Journal

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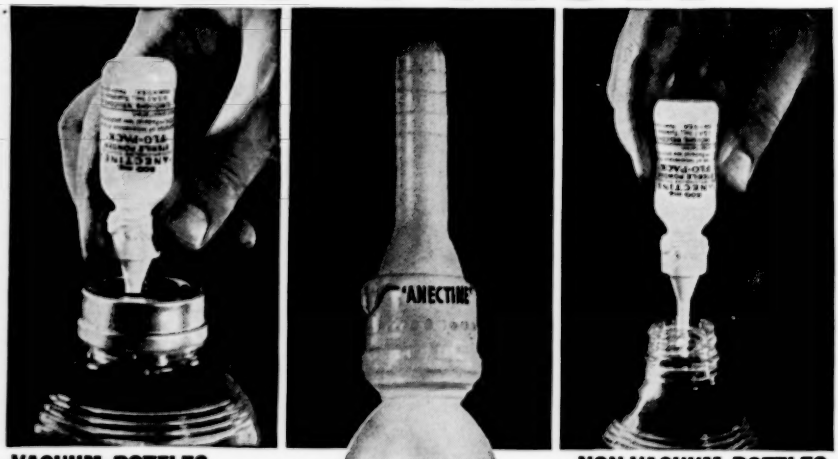

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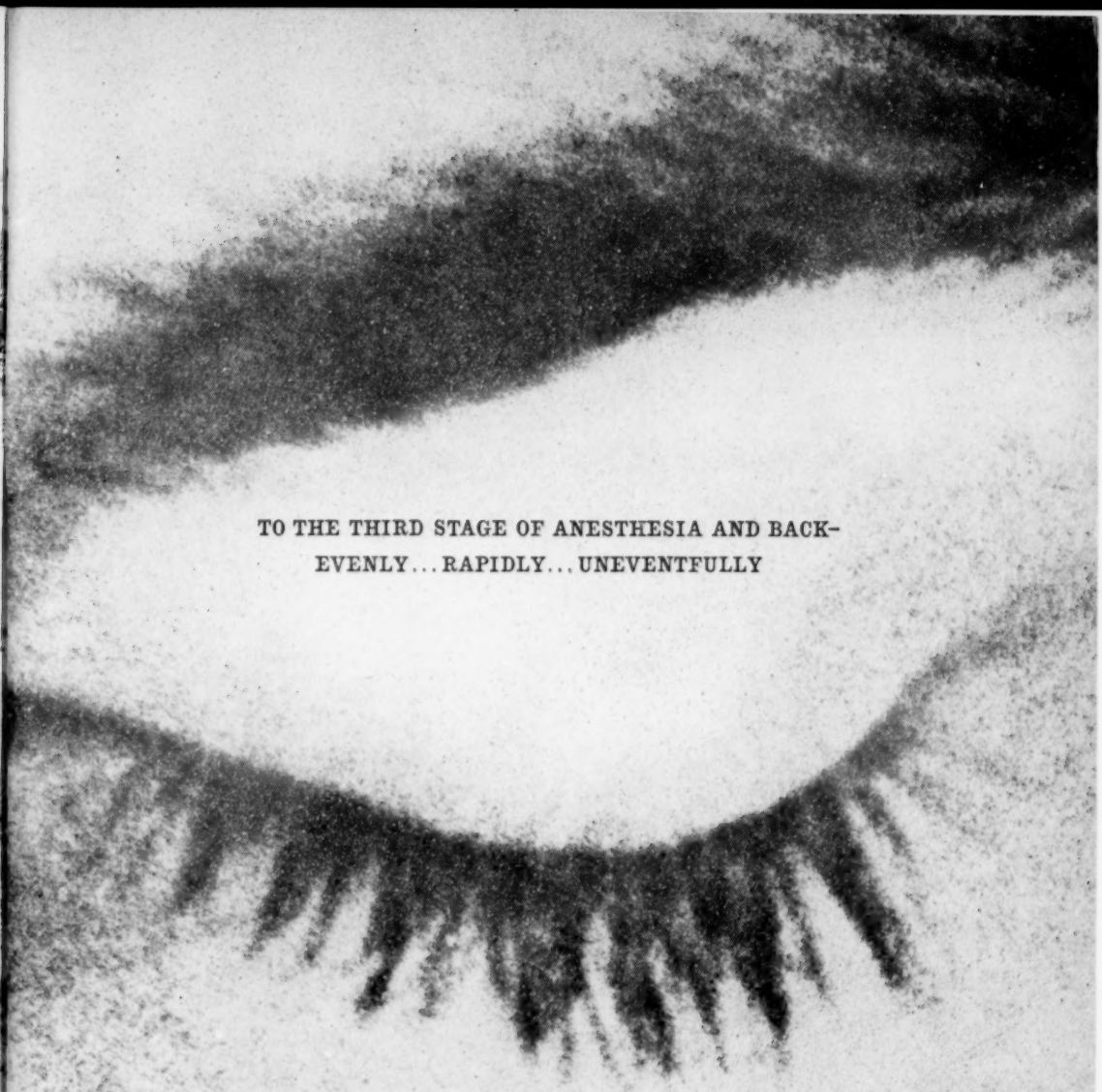

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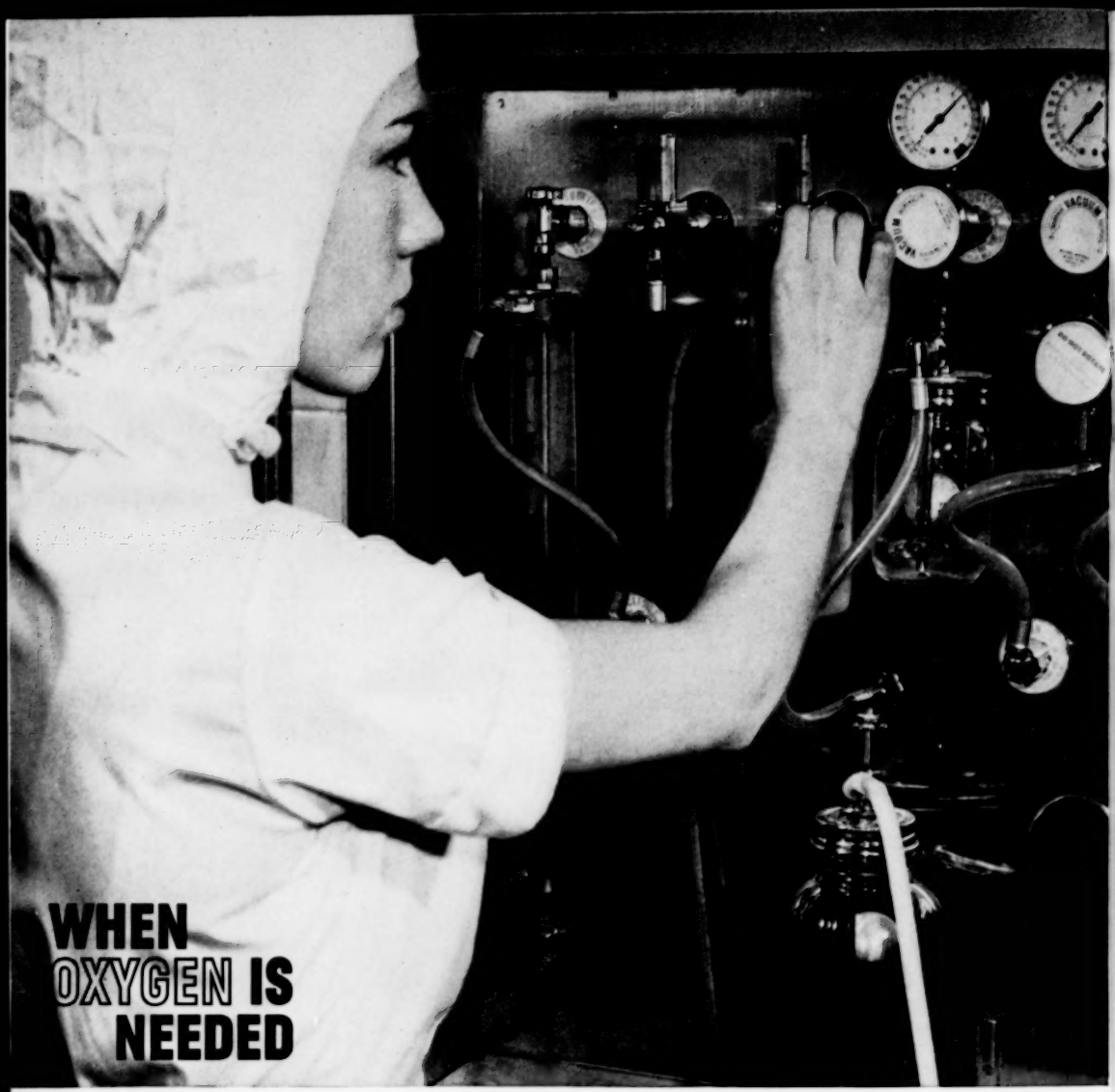

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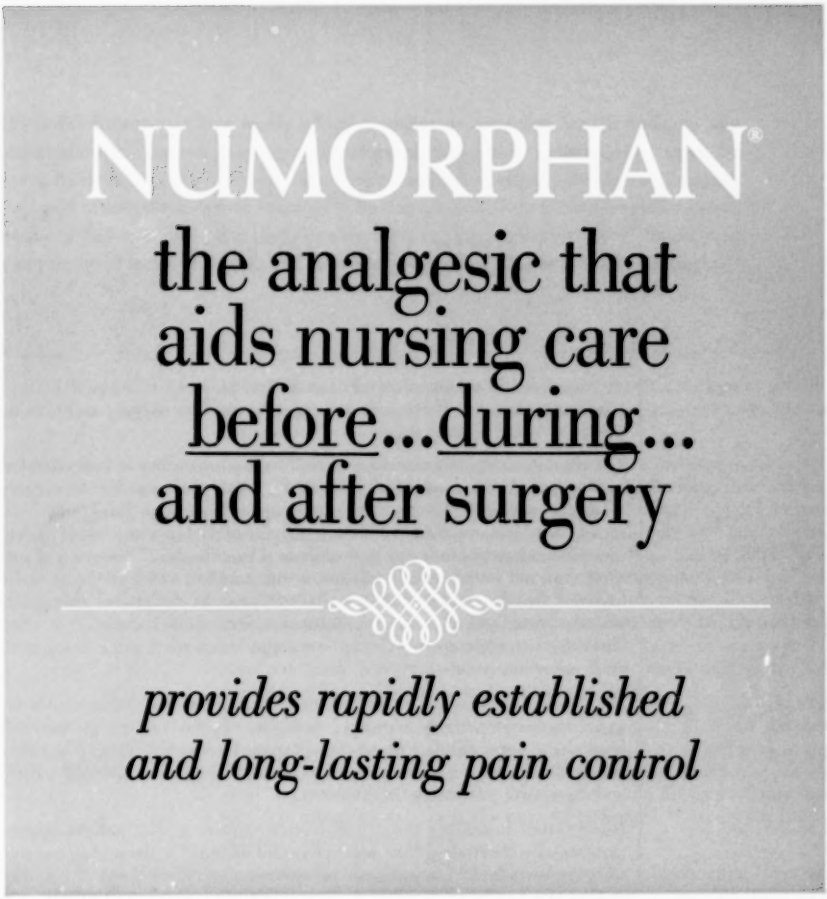

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fewer injections required

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1. Appleton, J. C.: Anesth. & Analg. 39:505, Nov.-Dec., 1960. 2. Seigleman, M., and Wasmuth, C. E.: Cleveland Clin. Quart. 27:157, July, 1960. 3. Coblentz, A., and Bierman, H. R.: Fed. Proc. 14:327, Mar., 1955; New England J. Med. 255:694, Oct. 11, 1956. 4. Rondeau, Y.; Knaff, M., and Keeri-Szanto, M.: Union méd. Canada 90:48, Jan., 1961. 5. Adriani, J.: Postgrad. Med. 27:723, June, 1960.
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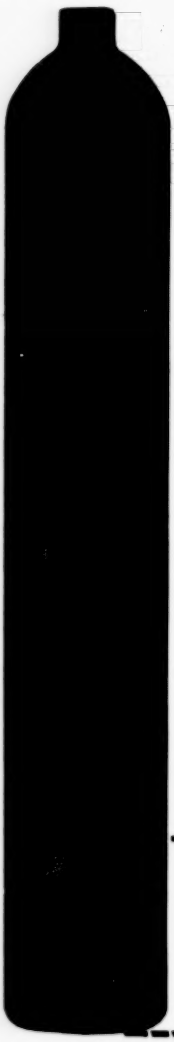

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THE PARENTERALS PAGE NUMBER 10

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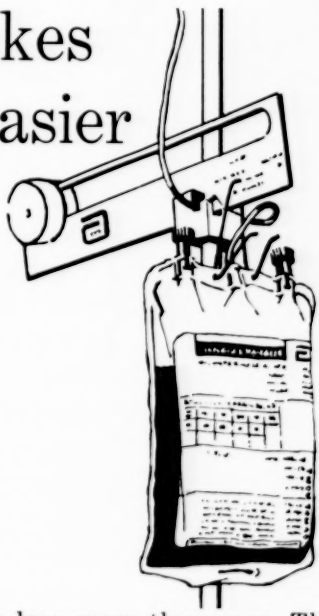

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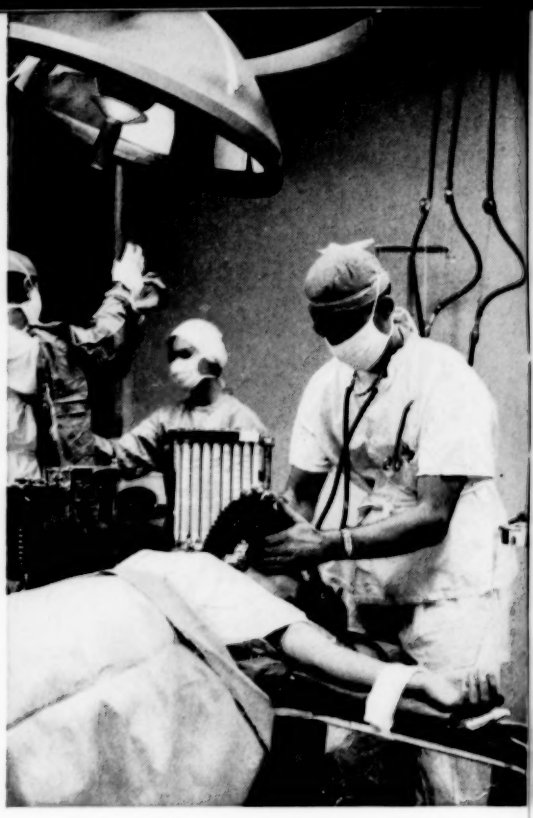

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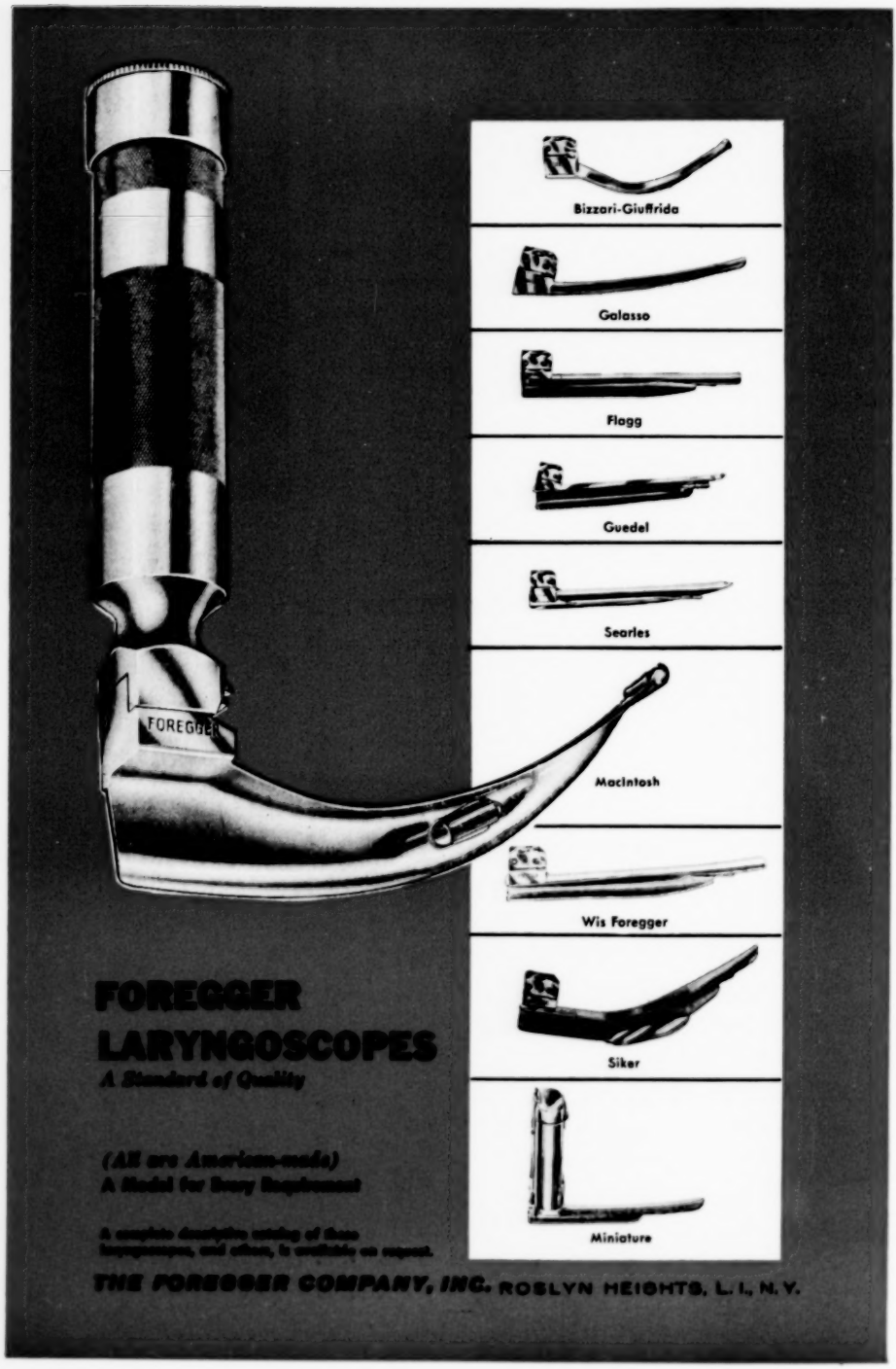
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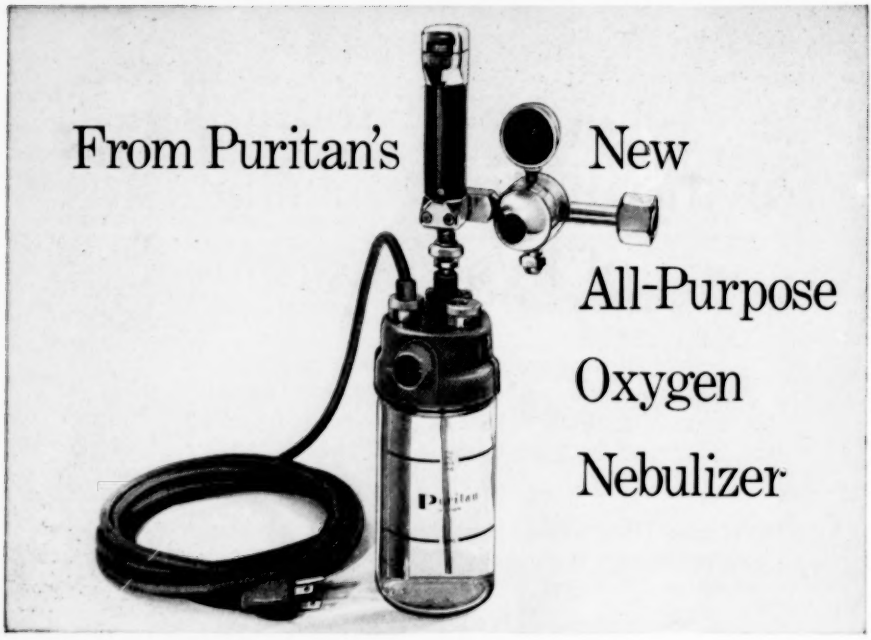

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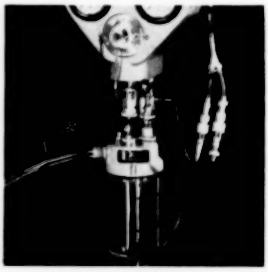

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Pediatric Anesthesia

Donna M. Christensen, Major, ANC*
San Francisco, California

INTRODUCTION

A great deal has been written about this topic of "Pediatric Anesthesia." There are probably as many philosophies concerning it as there are persons administering anesthesia to the pediatric patient. I am not going to tell you what to do, but I hope to bring before you some ideas and facts to keep in mind when you are working with these patients. Each anesthetist must select his or her own agents and methods to fit the situation. This includes the type of surgery to be performed, condition of the patient, facilities available and, last but not least, his or her own abilities.

Before beginning the discussion, we should become familiar with the meaning of some of the terms that we use in talking about pediatric patients. First of all, what do we mean by "pediatrics?" The pediatric patient is usually considered to be under the age of twelve. An infant is under two years of age. Pediatrics can further be subdivided into "neonate"—a newborn infant during the first 28 days of life[14] and "premature" — an infant weighing less than 2.3 kg. (5 pounds) regardless of the gestation period. These infants offer one of the greatest challenges in anesthesia because of their incomplete development.

Why is it necessary to consider pediatric anesthesia separately rather than in general when discussing anesthesia? After the turn of the twentieth century, a special branch of medical science concerning the treatment of disease in children (pediatrics) came into being. Before that time there was little understanding of the problems of child health. Infants and young children were regarded as "miniature adults."[3] We in anesthesia are becoming more aware of the specialty of pediatrics as time goes on. It has opened up a new specialty in the field of anesthesia, requiring special equipment and considerations in working with and understanding these patients.

The child's physiology is different from that of the adult. He is not just a "small adult." The respiratory and circulatory systems are extremely important and we should always keep the following in mind:

1. These two systems are most affected, even under favorable circumstances, by operation and anesthesia.

2. These two systems change profoundly during a short period of time in the newborn and during infancy.

3. Relatively minor changes in circulation or respiration may have more serious effects in an infant and small child than one would expect.[4]

---

* Director, School of Anesthesia, Letterman General Hospital, San Francisco.

Presented at the meeting of the Western States Section of Nurse Anesthetists, San Francisco, April 26, 1961.

Respiratory System

In the premature infant we find an inefficient respiratory system. This is compensated for by a very rapid respiratory rate and greater physical effort on the part of the infant. This in itself can be distressing to the anesthetist. Another factor is the inability of the premature infant to cough efficiently. In discussing respiration in children as well as in all patients, we are concerned more with the amount of gaseous exchange at the alveoli than the amount going in and out of the lungs through the respiratory tract. There are several things that can interfere with this gaseous exchange at the alveolar bed.

Compliance is directly related to body or lung size; although, on the basis of lung weight, the newborn infant's compliance is about half that of the adult.

Flow Resistance can greatly interfere with exchange. Resistance can be great with small air passages and may be increased by anesthetic apparatus or, in the case of infants, by relaxation of laryngeal structures.

Increase in Dead Space with the anesthesia equipment will interfere greatly with effective ventilation. This is much more apparent in the infant than in the adult.

Due to the deficiency of the infant respiratory system and the irregular type of respiration, it is often better to assist or even control the infant's respirations to insure adequate ventilation. This all means that the pediatric patient has a very delicate respiratory system that needs our constant attention and as anesthetists we should be aware of this and handle the child accordingly. A slight interference with ventilation in the small child can be disastrous.

Cardiovascular System

The premature infant has little cardiac reserve and is very susceptible to blood loss. Children in general do not tolerate blood loss. It is well established that the hemoglobin value of the blood of the infant at birth is higher than that of the adult. This also holds true for blood volume expressed in relation to weight. Normal circulating blood volume is about 40 ml./lb. Thus, a 10 pound baby has only to lose 40 ml. of blood, to lose 1/10 of his circulating volume. (Equivalent to 500 ml. in the average adult.)

The compensatory cardiovascular adjustments of the body are severely restricted due to the relatively small stroke volume discharging at a high heart rate. The infant heart is only slightly influenced by the vagus. It may be slowed by increased intracranial pressure, crying, or breath holding. The maximum variation in rate is from 60-180. Blood pressure readings are not too accurate due to the improper size of most cuffs. They can be used to indicate a change or trend in the pressure.

PREOPERATIVE PREPARATION

Psychological Preparation

The psychological preparation of the child undergoing anesthesia is one of the major aspects of modern anesthesia and surgery. This preparation begins at home. The parents can be a big help by explaining to the youngster why he is going to the hospital. The information should be honest and straightforward. There should be no promises made that cannot be kept.

The hospital personnel have a major role in the preparation of the child. This does not mean just the attending physician and ward nurse,

but everyone coming in contact with the child. He needs friends and attention and should not be placed in a crib and left to fare for himself. If the child is to have anesthesia, the anesthetist plays a major part in this psychological preparation. The child should be visited the day before surgery, preferably by the anesthetist who is to be administering the anesthetic. This will give the anesthetist the opportuntiy to learn by observation some of the things about the child that cannot be found on the chart. The visit likewise makes it possible for the child to have contact with someone who will be in the operating room, so when he arrives, there will be a friendly face and voice to greet him. The anesthetist should try to explain to the patient what is going to happen when he comes to surgery. If possible, she should take a mask or whatever she feels is necessary to ease the tension and help in the explanation. This is going to take time and patience, but it will tend to lead to a smoother induction the following morning and most important, a well prepared patient with minimal fear.

Pre-Anesthetic Preparation

The specific preanesthetic or preoperative preparation can vary depending on the circumstances. The ideal preparation would include a thorough physical examination. Particular attention should be paid to dehydration from such causes as vomiting and diarrhea. One should always check for cough, nasal discharge and fever. These conditions, if present, should be investigated and treated before subjecting the child to an anesthetic for elective surgery. Laboratory tests including urinalysis and hemoglobin should be obtained. At least 80 per cent of normal hemoglobin for this age group should be reached before surgery is undertaken. The over-all physical examination should include the cardiovascular and respiratory systems, the physical and mental development, as well as the general appearance of the child.

Pre-Medication

Before pre-medication orders are written, the physical examination and laboratory reports should be reviewed. The general condition of the youngster has a great deal to do with the choice of pre-medication. Some authorities believe that small children do not require medication except possibly a belladonna drug. Others feel that medication is as important in the pediatric patient as in the adult, and that the pre-medication should vary with the type of operation, age of child and with his physical and psychological make-up. The child may have a barbiturate for sedation one to one and a half hours before surgery. The belladonna drug and opiate should be given 45 minutes to one hour before surgery. The dosages should be governed by weight, not age. In older children who appear apprehensive and nervous, it might be wise to give a barbiturate the night before surgery to insure a good night's sleep. Great care must be taken in administering these drugs as they are given in very small doses. There can be many individual preferences in regard to pre-medication and we should always keep the welfare of the child uppermost in mind. He is entitled to the same considerations in regard to his emotional state on arrival in the operating room as the adult.

An excellent chart to use as a guide for pre-medication is one prepared by Drs. Bissonette and Ploss. It gives age, weight, doses of barbiturates, opiates, and belladonna drugs.

AGE	WEIGHT (In Lbs.)	Seconal or Nembutal (Rectal Dose) (mgm)	Morphine (mgm)	Demerol (mgm)	Atropine or Scopolamine (mgm)
Newborn	Up to 8#	None	Not Indicated	Not Indicated	0.1 to 0.15
1- 4 mos.	10-14#	15	"	"	0.1 to 0.15
4-12 mos.	14-21#	15	"	"	0.1 to 0.15
1- 2 yrs.	20-25#	30	1	10	0.15
2- 3 yrs.	25-30#	45	1	15	0.15
3- 4 yrs.	30-35#	45	1.5	20	0.2
4- 5 yrs.	35-40#	60	2	25	0.2
5- 6 yrs.	40-45#	60	3	30	0.2
6- 8 yrs.	45-60#	60	4	35	0.3
8- 9 yrs.	60-65#	75	5	40	0.3
9-10 yrs.	65-70#	75	6	45	0.3
10-11 yrs.	70-75#	90	6	50	0.3
11-12 yrs.	75-85#	90	6	75	0.4

Extracted from "Suggested Pre-anesthetic Medication Schedule," H. W. Bissonnette, M.D. and R. E. Ploss, M.D. Chart distributed by R. A. Hawks Division, Sierra Engineering Co., Sierra Madre, California.

There are advantages as well as disadvantages regarding preanesthetic medication.

Each person administering an anesthetic to a pediatric patient should weigh the advantages against the disadvantages of preanesthetic medication and make each decision on an individual basis. The patient between 18 months and 5 years of age can be the greatest problem. He is too young to understand the reason for surgery and can easily be hurt emotionally. The patient over 5 years of age, when handled carefully and wisely, can be treated much like an adult in regard to preoperative care and medication. Premedication and anesthesia should be selected to leave no bad memories. This is particularly true in the age group under 5 years.

	ADVANTAGES	DISADVANTAGES
OPIATES	1. Alleviate pain	1. Depress respiration
	2. Create feeling of well-being	2. In large doses may increase induction time
	3. Basal narcosis	3. Increase incidence of postoperative nausea and vomiting
	4. Prevent rapid respiratory rate	4. Itching of nose
BARBITURATES	1. Sedative in absence of pain	1. Large doses depress respirations
	2. Reduce amount of anesthetic required	2. Retard induction
	3. Aid in preventing rapid respiration	3. Occasionally cause excitement
	4. Reduce incidence of convulsions	
	5. Reduce nausea and emesis	
BELLADONNA DRUGS	1. Decrease secretions in air passages	1. Increase metabolic rate
	2. Conserve body fluids	2. May raise body temperature
	3. Protect against sudden death	3. May produce excitement
	4. Scopolamine usually has sedative and amnesic effect	4. Cause discomfort due to dryness of mouth and throat
	5. Stimulate respiration	5. May cause inspissation of secretions in respiratory tract (atelectasis)[5]

Preoperative Food and Fluid Intake

Preoperative preparation in regard to food and fluid intake is very important. Care must be taken to avoid ketosis and dehydration, yet equal care must be taken to avoid regurgitation of stomach contents during induction. The old stand-by order "nothing by mouth after midnight" might be all right for the adult, but not for the child. The child's daily intake and output of water is greater than the adult, but his reserve is proportionately smaller. It might be better to permit children and particularly infants to have clear fluids up to two or three hours before surgery. If this is not feasible, perhaps intravenous fluids should be administered to prevent dehydration.

TECHNICS AND PROCEDURES

Selection of Equipment

The selection of equipment is one of the most important phases of the anesthetic. Not only must there be the actual equipment that is planned for use, but there must be ready equipment to meet any emergency. For all cases there should be a laryngoscope and endotracheal tubes of various sizes. There must be some means of administering artificial respiration, whether it be through an endotracheal tube or by means of bag and mask. There should be airways, means of suctioning the pharynx and trachea and equipment for administering intravenous medication or fluids.

In this modern age there are technics and equipment adapted to fit most any age or size of patient. In selecting equipment, one should consider the surgery to be performed, the condition of the patient, minimizing dead space and the familiarity with and ability of the anesthetist to utilize the equipment. Fancy and complex equipment may sound and look good, but unless the anesthetist is familiar with its use and at ease with it, it is no better than the older and simpler technics.

Open Drop

The open drop method is a technic that is most often thought of in relation to pediatric anesthesia. It is extremely important to be able to administer a smooth anesthetic with the open method. From the teaching standpoint, it is the best way to study signs and stages. The method has its drawbacks and with modern surgical procedures the technic must often be supplemented or use must be made of other technics. The open drop method has simplicity in the amount of equipment necessary. Commercial masks of various sizes are available. Some are equipped with nipples for the addition of oxygen or a catheter under the mask may be used with oxygen flowing to circulate the vapor and provide the addition of oxygen to the inhaled mixture.

Non-Rebreathing

Non-rebreathing is becoming a more and more popular technic for children. This can be used with most of the anesthetic agents and can be adapted to varying circumstances. It can be used by bag and mask with some form of non-rebreathing valve and is easily adapted to use with an endotracheal tube. Any system with a bag incorporated in the system has the advantage of providing for assisted or controlled respirations of the patient.

When using an endotracheal tube, an Ayres "T" tube or Slocum tube can be incorporated in place of the bag and valve. These two methods are less cumbersome than methods in which a machine is used and allow the patient to breathe in not only the anesthetic mixture, but some room air as well. They are best utilized in patients weighing less than 35 pounds. Assistance to respirations can be carried out very satisfactorily merely by placing the finger over the open end of the "T" tube or hole in the Slocum tube.

Advantages of the Non-Rebreathing Technic

1. Resistance is small.
2. Dead space is minimal (valve proper only 10 cc.).
3. Assisted and controlled respiration. (Flow of gases must at least equal to the patient's minute volume. The breathing bag must be kept full, but not distended.)

Circle Technic

In the past it was thought that the circle system was not to be used for pediatrics. It was thought to have too much dead space and resistance. This is still true so far as adapting the adult circle equipment for use in pediatric anesthesia. Today, with modern equipment, there are circle systems specifically designed for infants and small children. With the insertion of directional valves at the face mask or endotracheal tube and short breathing tubes, the regular circle system can be adapted for use in larger children. The important thing to keep in mind at all times is to maintain as near normal physiology in the patient as is possible, eliminating deadspace and resistance.

Intravenous Technic

Intravenous anesthesia for children is used very successfully by many anesthetists. Those using it feel that a small venipuncture is psychologically less traumatic to the child than induction by inhalation anesthesia. One must be extremely cautious with intravenous medication because once it is in the vein, it cannot be withdrawn. Doses for intravenous anesthesia in children **must be measured very carefully.** It would be very easy to give an overdose to a small child when using adult medications.

Endotracheal Technic

The use of the endotracheal tube in children is as important as its use in adults. There are still some persons who feel that it is harmful to intubate a child. The child's tissues are delicate and care should be taken to avoid trauma. Before intubating the pediatric patient one should keep in mind a few anatomic differences as compared to the adult.

1. The larynx is higher in relation to the cervical vertebrae.
2. The epiglottis is curved from side to side, not a flat and spade-like structure.
3. The narrowest part of the larynx is at the cricoid ring, not at the level of the cords.
4. Tracheal size doubles its volume in the first two years of life.
5. Tracheal size relative to total lung volume rapidly decreases over the first two or three years.

The selection and care of the endotracheal tubes are extremely important. Probably the biggest controversy regarding intubating children is the possibility of postoperative tracheitis and edema. There is really no need for endotracheal anesthesia being condemned for this reason. Some of the causes are:

A. Mechanical Trauma
   1. Use of a large laryngoscope.
   2. Use of large endotracheal tubes requiring forceful passage. (Correct size is extremely important.)
   3. Unnecessary roughness.
   4. Intubation while the patient is inadequately relaxed.
   5. Faulty positioning of the head. Hyperextension angulates the trachea at the larynx.
   6. Difficult intubation due to anatomic abnormalities.
   7. Continued motion of the tube during anesthesia.
   8. Drying of mucosa.

B. Chemical Trauma
   1. Inadequate rinsing of sterilizing solutions.
   2. Lubricating ointments.

C. Contamination
   1. Inadequate cleansing of equipment.
   2. Improper storage after cleansing.
   3. Careless handling of tubes before insertion.
   4. Use of contaminated lubricants.
   5. Intubation in the presence of upper respiratory infection.

To avoid excessive handling of tubes, they should be clearly marked as to size and length and stored in a manner so they can be seen easily without handling. A guide for correct size of endotracheal tube for each age group is a chart prepared by Doctors Bissonnette and Ploss. It gives anatomic distances as well as the correct size of endotracheal tube for various age groups.

The connector for the tube is just as important as the tube itself. It should be the largest in diameter that can be used in the tube without splitting it. There should be enough tubes with a variety of connectors so that connectors need not be changed from one tube to another. The connectors, whether curved or straight, should be such as to eliminate dead space and resistance.

Agents

The question arises, "What is the best agent to use for pediatrics?" This definitely depends on the condition of the patient, the procedure to be performed and, most important of all, on which agent the anesthetist is best qualified to administer in the given situation. Any agent that can be used for adults can be used for children so long as the anesthetist keeps in mind the safety of the patient.

Barbiturates and muscle relaxants can be used as well as the inhalation agents so long as the doses are calculated to fit the patient. When using muscle relaxants, one **must** always be able to assist or control respirations. This is no different from the course of action when administering muscle relaxants to adults.

For open drop technics, induction with vinethene, gradually switching to ether, with oxygen flowing under the mask at all times, works well.

For non-rebreathing or circle filter technics, nitrous oxide and oxygen is used for induction, gradually adding ether. For a more rapid induction fluothane with nitrous oxide and oxygen are used, adding ether or continuing the use of fluothane, depending on the situation. For those who are not too familiar with fluothane, extra care must be taken with its use as it is a very potent and rapid acting agent.

Cyclopropane, of course, can be utilized very well for the pediatric patient. It is used very little in our hospital, probably because we find that many times we can accomplish the same thing with other agents. At the present time, fluothane seems to be our most popular agent. We have used it for practically every type of surgical procedure in the pediatric patient, and find it particularly good for surgery about the head and neck. All of our patients for heart surgery are anesthetized with fluothane. The anesthesia for these patients is sometimes supplemented with muscle relaxants. The anesthetic agent is only as good as the individual administering it.

SUMMARY

In dealing with the pediatric patient, we must keep in mind that he

AGE	WEIGHT (In Lbs.)	ANATOMIC DISTANCES (In cm.)			ENDOTRACHEAL CATHETER SIZES		LENGTH OF CATHETER (Cm. from midpoint to bevel)	
		Teeth to Carina	Teeth to Cords	Length of Trachea	French Size	"Portex" Magill	Naso-Tracheal	Orotracheal
Infant	up to 8#	12	8	4	12, 14	0	Diameter — Should be largest accepted by nasal passage. Length — Add distance from midpoint of upper teeth to tip of nose to the orotracheal length for age.	11, 12
6 mo.	8-18	12	8	4	14, 16, 18	1, 1A		11, 12
½-2 yr.	18-30	13	8.5	4.5	16, 18, 20	1, 1A, 2		12, 13, 14
2- 3 yr.	30-35	14	9	5	18, 20, 22	1A, 2, 2A		13, 14
3- 4 yr.	35-38	14.3	9	5.3	20, 22, 24	2, 3, 4		14, 15
4- 6 yr.	38-44	15.5	9.5	6	22, 24, 26	2, 3, 4		14, 15, 16
6- 8 yr.	44-55	15.5	9.5	6	25, 26, 27	3, 4, 5		15, 16, 17
8-10 yr.	55-70	15.5-17	9.5-10	6.3	26, 27, 28	4, 5, 6		15, 16, 17, 18
10-12 yr.	70-85	16.3-18.5	10-11	6.3	28, 29, 30	5, 6, 7		16, 17, 18, 19
					(Divide by 3 for diam. in mm)			

EXTRACT FROM: Bissonnette-Ploss Anesthesia Index, R. A. Hawks, Division Sierra Engineering Company, Sierra Madre, California.

is an individual with his own anatomy and physiology. The specific situation should be considered and weighed when selecting the anesthetic equipment, agent, and method to be used for the administration of the anesthetic. The child has feelings and the anesthetist should try to understand him and gain his confidence.

Our job is more than just administering the anesthetic. We must always remember that we have that small life in our hands and if we will give the child a free airway for respiratory exchange, adequate oxygen and fluid and blood replacement, we can bring him safely through surgery and anesthesia.

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Anesthesia for Pediatric Cardiac Surgery

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I. PREPARATION

Children undergoing cardiac surgery deserve the best possible preparation since the outcome can be determined by small details. These patients should be in optimal condition, and time should be taken to allow complete recovery from unrelated illnesses. From the psychic point of view, it is especially important to get the children into a proper frame of mind, because emotional outbursts and fatigue can cause severe hypoxia in children with cardiac disease. One must guard against the tendency to rush the child about the hospital on the day before operation in order to get X-rays and E.K.G., laboratory work-ups and such. This will completely exhaust and bewilder the child and leave him in poor condition on the morning of the operation.

Medication before operation is indicated in sufficient quantity to bring about vagolitic and anti-secretory effects and to have the child in a drowsy state prior to operation.

II. CARDIAC CATHETERIZATION

All patients, before being subjected to open cardiac surgery, first undergo cardiac catheterization. This enables the cardiac team to make a more accurate diagnosis and to more adequately determine the severity of the cardiac deformity of each individual patient.

As a final step in the evaluation of the cardiac patient at Children's Hospital, East Bay, Oakland, each individual patient, after having been adequately studied—(i.e., having had all physical data, laboratory work, X-ray, cardiac catheterization reports and angio-cardiography, if indicated), are presented to the cardiac team for discussion before surgery.

This team consists of surgeons, cardiologists, pediatricians, and anesthesiologists, as well as nurses of the surgical and postoperative team. At this time the various members of the team discuss not only the advisability of cardiac surgery, but the optimal time for such operation. If the team feels that the patient should be delayed for further study, or re-evaluated at a future date, surgery is deferred. If the various members of the team agree that surgery is of definite value to the patient and that he is in optimal condition, the procedure to be done and technique employed is discussed before surgery. In this way each member of the cardiac team is cognizant of the patient's cardiac anomaly, the risk involved and exactly what is contemplated in surgery.

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This paper presents one phase of a problem. A second phase is presented in the following paper by Dr. Kenneth L. Schroeder.

III. ANESTHETIC REQUIREMENTS

Light, even anesthesia without relaxation is desired in thoracic surgery. Any of the general inhalation agents, or combination of intravenous and inhalation agents, have proved satisfactory, using a closed system. The infant circle is used for children weighing under 35 lbs. and the adult circle for children weighing over 35 lbs. Adequate ventilation must be insured by controlled respiration at all times. Throughout the whole procedure it is essential to monitor the heart action. We feel that this is best done by placing an esophageal stethescope and by direct observation of the heart while the chest is open. Visual observation of lung inflation is also carried out and is a most valuable guide to the anesthetist. We also feel that important changes in the force or rhythm of the heart can usually be recognized more promptly by watching the heart than by E.K.G. or other instruments.

IV. BLOOD REPLACEMENT

The great problem which is common to all cardiac operations is actually not that of ventilation but of blood replacement. The hazard of blood loss and shock is great, but that of over-replacement can be even more perilous. The nature of the problem varies somewhat in each of the different types of operation.

The problems which arise during operations for congenital heart disease may include hypoxia, hypercapnia, hypertension, arrhythmias, shock, pulmonary edema or myocardial depression. In most instances, management of the anesthesia is relatively easy. The anesthetist will find the origin of most of his troubles to be alterations in hemodynamics and will be able to function more effectively, firstly, if he is aware of the effects of both the heart lesion and the operation and, secondly, if he follows the progress of the operation carefully in order to catch signs of cardiac or pulmonary abnormality at their first appearance.

Vascular Ring

The term vascular ring is used to include a number of anomalies of the aortic arch and great vessels, all of which act to compress the trachea and esophagus. The anomalies most

Operations on Heart and Great Vessels

1. Cardiac Catheterization
2. Conditions Amendable to Closed Heart Techniques
   a. Vascular ring
   b. Patent ductus arteriosus
   c. Tetralogy of Fallot
   d. Coarctation of the aorta
3. Heart Lesions Requiring Hypothermia
   a. Patent ductus in poor risk patient
   b. Infantile coarctation
   c. Transposition of the great vessels (Baffes procedure)
   d. Accompanying by-pass surgery
   e. Tricuspid atresia
4. Heart Conditions Requiring Extra-Corporeal Circulation
   a. Intra-atrial septal defect
   b. Intraventricular septal defect
   c. Pulmonic stenosis
   d. Aortic stenosis
   e. Anomalous venous return
   f. Tetralogy of Fallot

frequently seen are; 1. double aortic arch, 2. right aortic arch with left ligamentum arteriosum, 3. anomalous right subclavian artery, 4. anomalous inominate artery, 5. anomalous left common carotid artery. The double aortic arch is most frequently seen and is the most troublesome because of the marked degree of tracheal and esophageal contraction, and also because of the greater difficulty in operative correction. Vascular rings are not cardiac lesions and no intracardiac abnormality is involved. The obstruction of the trachea and the esophagus constitutes the entire clinical problem.

In the symptoms of these anomalies either esophageal or tracheal obstruction may predominate, depending upon which organ is more severely compressed. In mild cases symptoms may be lacking, but in general they appear during infancy in the form of stridor, recurrent respiratory infection, and cough or in difficulty in eating and postpranidial vomiting. Infants with marked tracheal compression often lie with their heads arched backward in an opisthotonic position to keep the trachea on the stretch. Diagnosis is made by tracheoscopy and esophagoscopy if a pulsating constriction is seen in either the trachea or esophagus. Final confirmation is made by X-ray evidence of indentation of the trachea or esophagus by the constricting vessels. Compression of the vessels usually occurs just above the carina.

If the compression is caused by an actual ring of vessels, one section of the ring must be divided to give relief. In the case of an anomalous inominate artery or anomalous carotid artery, the difficulty arises merely from the fact that these vessels lie across the anterior aspect of the trachea and compress it. Relief is gained by removing the thymus and pulling the offending vessel forward and suturing it to the sternum.

In the anesthetic management of these children, the problem of respiratory obstruction is the chief concern.

Patent Ductus Arteriosus

The ductus arteriosus is a normal fetal shunt from the pulmonary artery to the aorta, and closes in most infants in the first few weeks of life. Failure of the normal obliteration process allows blood to flow between the systemic and pulmonary circulations. At birth the pressure in the aorta is only slightly greater than in the pulmonary artery and shunting is not significant nor is it great enough to set up a murmur. In a few months, however, the systemic pressure in the aorta increases and enough blood is forced into the pulmonary artery to set up a murmur, first in systole alone, then both in systole and diastole. This is a characteristic loud, continuous or "machinery" type murmur.

The hemodynamic effect of the patent ductus is that of a leak from the systemic circulation into the pulmonary artery, a left-to-right shunt. During systole a forceful contraction maintains normal arterial pressure, but during diastole, peripheral resistance falls sharply because of the free escape of blood through the ductus, hence diastolic pressure is abnormally low. The pulmonary vessels must carry an increased volume of circulating blood, and with large shunts, the pulmonary flow may be increased to three or four times normal. The increased vasculature of the lungs is evident by X-ray, and pulsation of the hilar vessels, or "hilar dance" is evident by fluoroscopy.

With a shunt from the aorta to the pulmonary system, blood which has already been oxygenated is inefficiently recirculated through the lungs without going to the tissues. Because the left heart must continue to re-circulate this extra load, the left ventricle may eventually show enlargement and failure.

The clinical effect of a patent ductus is usually slight. With large shunts the child's development may be retarded. Cyanosis is not associated with the lesion, unless unusually high pulmonary pressure causes reversal of flow through the ductus. Operative ligation or division is indicated to prevent later development of an endocardial infection or cardiac failure.

Operative and anesthetic management of the usual patent ductus involve little difficulty or danger other than that of hemorrhage from a major vessel. The operation re-establishes normal anatomy, and recovery may be expected to be rapid and uncomplicated. Formerly it was thought best to wait until children were 6 to 8 years of age, but improved techniques of anesthesia and surgery have made it possible to operate safely on the infant patient.

There is a much less pleasant aspect of patent ductus surgery which involves abnormally large shunts with pulmonary vascular obstruction. The diagnosis of these cases is less easily made, and some of them were missed prior to the widespread use of cardiac catheterization techniques. An appreciable number of infants are now being found who have such high pressure in the pulmonary vessels that reversal of flow occurs in the ductus. The ductus then acts as a safety valve, allowing release of pulmonary pressure by overflow into the aorta. When this occurs there may be cyanosis of the lower part of the body.

The surgical correction of large shunts of this nature must be performed in the face of high risk, since death may occur shortly after closure of the ductus. A 50% mortality has been associated with correction of ductus shunts with reversal of flow.

Tetralogy of Fallot

Tetralogy of Fallot is the most common type of cyanotic heart disease. The syndrome consists of pulmonary valve stenosis, overriding of the aorta, ventricular septal defect and hypertrophy of the right ventricle.

The resultant abnormal circulation, where returning venous blood enters the right auricle and ventricle, is largely obstructed in its normal course through the pulmonary artery, but diverts through the ventricular septal defect and into the aorta. By this process un-oxygenated blood again proceeds to the tissues without passing through the lungs.

Children with this lesion are markedly cyanotic, show clubbing of their fingers and toes and have a greatly decreased exercise tolerance. It is characteristic of children with tetralogy to squat at intervals when fatigued and the frequency with which they have to squat is one of the best means of judging the severity of their condition.

Tetralogy may be fatal during infancy, consequently, operation is often indicated in very small, weak patients who have already experienced hypoxic episodes or cerebral thrombosis. In the evaluation of such patients, one must look for such items in the history and physical examina-

tion and then investigate the status of the blood. Hemoconcentration occurs as a compensation for hypoxia, but the bone marrow often over-compensates and the hemoglobin may be 19 or 20 Gm. per cent; and the hematocrit as high as 80 or 90%. Hemoconcentration increases the risk of thrombus formation, and must be borne in mind at all times. Prior to operation, fluids are not restricted, but encouraged the evening before operation and an infusion is ordered as supplementation. Premedication of cyanotic patients is essential and should be liberal.

Operation for tetralogy usually consists either of the Blalock end-to-side anastamosis of the subclavian artery to the pulmonary artery, or the Potts procedure by which the aorta is anastamosed to the pulmonary artery (side to side). However, both of these operations are palliative and do not effect an anatomic cure. Corrective operation is possible by use of the pump-oxygenator. In the case of the infant too small for bypass surgery, either a Blalock or Potts procedure may be done in order to tide the patient over until he is large enough to have a more definitive type of correction using the heart lung machine.

During either the Blalock or Potts procedure, the anesthetist is faced with two major problems, hypoxia and hypotension. The danger of hypoxia is obvious because of pre-existing cyanosis. The most critical point of the operation is when one pulmonary artery is occluded for performance of the anastomosis. If the blood flow through the other pulmonary artery is inadequate, the child may not tolerate the procedure. Severe cyanosis and bradycardia will be followed by cardiac standstill. Once committed, the surgeon usually must finish the anastomosis as quickly as possible, while the anesthetist tries to keep the patient alive by ventilating with 100% oxygen and adding atropine intravenously to counteract vago-tonic reflexes.

Hypotension often is more of a hazard than hypoxia during operation for tetralogy of Fallot. These patients carry a low blood pressure initially. Induction of anesthesia may lower blood pressure appreciably, especially if ether is the agent employed. Blood loss and myocardial depression also will be mirrored by a rapid development of hypotension. Since these children are already hypoxic, hypotension is intolerable. In these patients, more than any others, shock must be avoided.

After completion of the anastomosis, it becomes essential to maintain adequate arterial pressure in order to keep blood flowing through the shunt, otherwise the shunt may thrombose and remain nonfunctioning.

The usual course of the Blalock or Potts operation is marked by a blood pressure bordering on shock level, increasingly rapid pulse, and slightly increased respiratory rate. Respiration is carefully assisted or controlled at all times.

The anesthetist follows the color of the patient, the amplitude of the pulse, and the blood pressure, with great care. He also monitors the cardiac sounds and respiratory exchange with a stethoscope, but his chief interest is watching the action of the heart. If either the surgeon or the anesthetist notices any change in the character of the heart beat, he immediately calls it to the attention of the other so that both can take appropriate steps. If possible the sur-

geon interrupts his work and allows full oxygenation and relief of constricting forces on the trachea or vasculature. When normal cardiac activity is re-established the operation is resumed.

Pulmonary Stenosis With Intact Ventricular Septum

Children with this lesion have considerably less disability than those with tetralogy of Fallot. About one-fourth of them are asymptomatic, and when symptoms are present they consist predominately of dyspnea and fatigue, cyanosis being present in only about one-third of the patients. The danger underlying the disease is not hypoxia, as in tetralogy, but in right ventricular failure, due to the increased work of the right heart pushing blood through the narrow pulmonary artery.

It is now evident that pulmonary stenosis can be corrected more satisfactorily under direct vision. Since the use of hypothermia and the pump-oxygenator has proven advantageous and practical for the correction of this lesion, the Brock or blind instrumental procedure has largely been abandoned.

Coarctation of the Aorta

This condition consists of a constriction of the aorta which usually amounts to complete obstruction of flow. Survival depends upon the collateral circulation which may be of two types. In the simple or adult type of coarctation, which is usually encountered, the constriction occurs in the descending thoracic aorta, the ductus arteriosus is obliterated, and collateral circulation passes via the subclavian, internal mammary and intercostal arteries. In the less frequently encountered variety, the so-called "infantile" type, the coarctation is situated proximal to the ductus arteriosus which has remained patent. In these patients the left ventricular output flows via the ascending aorta to the head and arms, and upper body, while the lower body and limbs are supplied by the output of the right ventricle, which is carried by the patent ductus to the descending aorta. The operative implications of the two lesions are very different.

Simple coarctation usually produces no symptoms during the first ten years of life. Symptoms when present, consist of leg pain, headache and fatigue. Diagnosis is made by elevated blood pressure and by the further finding of absent femoral artery pulsation and of rib-notching.

In the preoperative evaluation of patients with coarctation, one should determine the blood pressure in both arms and legs and whether or not the patient has any femoral arterial pulsation. It is a better sign if leg pressure and femoral pulsation are poor prior to operation, for this shows that little blood passes through the coarctation and sufficient collateral circulation has been established to allow surgical occlusion of the aorta.

Patients requiring operation for coarctation are usually 10 years or older and in good physical condition. They tolerate anesthesia and do not offer great problems. The anesthetist should concentrate chiefly on watching the blood pressure and in managing blood replacement.

The operation is time consuming because of the large incision and careful preparation of the aorta itself. The danger of hypoxia and CO_2 retention is appreciable, and the anesthetist must try to prevent this by keeping the left lung partially inflated at all times. At intervals both lungs should be completely expanded.

The two most critical phases of the operation occur with the placing of the clamps on the aorta and later when the clamps are released. The rise in blood pressure when the clamps are applied will depend upon the degree of development of the collateral circulation. The maximum rise in pressure usually occurs in 5-10 minutes, following which the pressure levels off or falls slightly.

After completion of the anastamosis, release of the aortic clamps causes a marked reduction in peripheral resistance and their resultant fall in blood pressure may be severe. If blood replacement has not been adequate, sudden release of the aortic clamp may cause immediate death. The proximal aortic clamp must be released slowly, as the anesthetist checks the blood pressure. Should the pressure fall below 100 mm. Hg the clamp is reapplied and blood is pumped into the patient. Throughout the rest of the operation blood pressure should be maintained at not less than 100 mm. Hg.

In infants, coarctation may cause marked cardiac enlargement and failure. Operation may be indicated as a life saving measure. Anesthetic risk is increased by the patient's size, lack of collateral circulation and by the presence of myocardial failure. It has been our experience that these patients do well under hypothermia, nitrous oxide and oxygen, plus muscle relaxant anesthesia, using a closed system.

Tricuspid Atresia

This condition seldom exists as an isolated lesion. If accompanied by an atrial septal defect, then a successful Blalock or Potts procedure may be performed. The atrial septal defect is essential for the return of venous systemic blood to the left ventricle.

Patients with combined tricuspid atresia and atrial septal defect have all the symptoms and complications of patients with severe tetralogy of Fallot, and the anesthetic management is the same for both operations.

Transposition of Great Vessels

In transposition of the great vessels there is a rotation of the arterial trunks. The aorta arises from the right ventricle and the pulmonary artery from the left ventricle; thus non-oxygenated blood enters the systemic system and oxygenated blood enters the pulmonary system. These patients usually only live a few weeks, dying of cardiac failure. In the so-called corrected transpositions, the aorta and pulmonary artery are transposed but they still originate from their proper ventricles, and hypoxia does not occur.

Several operations have been devised for this condition, but all carry a high mortality rate. One operation interchanges the aorta and pulmonary artery, another re-routes the pulmonary veins into the right atrium and the superior and inferor vena cava into the left atrium (Baffes' operation).

Anomalous Pulmonary Veins

Of the patients operated for anomalous pulmonary veins, there are two types: 1. Those in which only some pulmonary veins empty into the right atrium, constituting a left-to-right shunt, or 2. Those in which all pulmonary veins drain into the right superior vena cava or right atrium, associated with an atrial septal defect.

The surgical procedure for both types is to transpose these pulmonary veins into the left atrium, and to close the atrial defect. However, patients with pulmonary hypertension rarely survive.

Techniques of Anesthesia for Pediatric Cardiac Surgery

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My discussion will be limited to that of techniques involved in managing anesthesia for specific cardiac lesions and a brief outline of the management of anesthesia for patients undergoing open heart surgery using the extracorporeal or so-called heart-lung by-pass technique.

Vascular Ring

The first of the specific lesions to be mentioned is that of vascular rings. The problem of respiratory obstruction is of chief concern in these patients inasmuch as the lesion itself usually is harmless except for the fact that there is tracheal and esophageal compression. The possibility of respiratory obstruction is a problem we are faced with whenever any patient undergoes anesthesia, but it becomes particularly hazardous with this type of lesion. There are several types of vascular rings, but the mechanism of producing tracheal and esophageal compression is the same in all of them, specifically, major vessels coursing along opposite sides of the trachea and esophagus. The diagnosis is suspected from the clinical picture, and is confirmed by esophagrams and/or bronchoscopy and tracheagrams.

We prefer to use Vinethene-ether open drop type of induction for the bronchoscopy and tracheagrams. During the bronchoscopy, anesthesia is maintained by flowing ether-oxygen through the sidearm of the bronchoscope. The surgeon tries to determine at bronchoscopy just which type of vascular ring is present, by compressing the pulsations of the trachea that are produced by the anomolous vessels. While he does this, the anesthetist feels for pulses in the arms and the neck. Depending on whether or not the pulses disappear, and which ones, if any, do disappear, it can be determined pretty well which type of ring is involved.

As soon as the bronchoscopy is completed, the trachea is intubated and anesthesia is then continued with ether-oxygen. The patient is then taken to X-ray where a water-soluble radio-opaque dye (Hypaque) is placed in the trachea by passing a small No. 8 French catheter through the endotracheal tube and injecting small amounts of the dye into the trachea under fluoroscopy. If a vascular ring exists, the tracheagrams will usually reveal an indentation of the tracheal wall.

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This paper presents one phase of a problem. Another phase is presented in the preceding paper by Dr. Woodrow E. Lomas.

Once the diagnosis is established the surgical treatment is performed by dividing the offending vessel to relieve the tracheal compression. The anesthesia for correction of a vascular ring is particularly hazardous because the site of the tracheal compression is usually immediately above the carina, and care must be taken to avoid inadvertently placing the endotracheal tube through the narrowed segment and into one of the main stem bronchi. On the other hand, placing the endotracheal tube proximal to the obstruction can result in inadequate aeration and, needless to say, unsatisfactory and unsafe anesthesia.

It is particularly important to use the proper size endotracheal tube in these patients, because, even at best, there will be some traumatic edema postoperatively at the site of the previously constricted area of the trachea. This is almost unavoidable because of the necessary manipulation of the intubated trachea by the surgeon during the operative procedure. It is, therefore, important that all of these children be placed in a cool mist tent postoperatively to decrease as much as possible any additional edema, and it is imperative that they be observed constantly for signs of respiratory distress. Tracheostomy is done, not as a last resort, but when it is first apparent that respirations are not adequate. The tracheotomy tube, obviously, must extend beyond the point of obstruction, or little relief is obtained. The results from release of a tight vascular ring are dramatic.

Patent Ductus Arteriosus

The next specific lesion to be discussed is that of patent ductus arteriosus. The anesthesia management for division of a P.D.A. involves little danger other than that of hemorrhage from a major vessel. Therefore, a route for rapid administration of blood must be available. On infants and small children an intravenous cutdown is essential; on the older children with large veins at least two No. 18 gauge needles should be securely in place before actual surgery begins. Blood, needless to say, *must* be *immediately* available for administration in the event of major hemorrhage. Blood may not be given at all, if there is minimal bleeding during the procedure, because these children may be hypervolemic from their disease.

These patients are always intubated as is true with any open chest surgery. The particular agent one uses is not as important as how to use the agent. Because of the use of electric cautery, we prefer either Fluothane-nitrous oxide-oxygen, or the Pentothal - succinylcholine - nitrous oxide-oxygen sequence. Constant cardiac monitoring is achieved by use of the esophageal stethoscope. It is quite dramatic when the typical patent ductus murmur disappears at the moment the ductus is clamped.

Blood pressure monitoring is particularly important in this procedure. Typically, the diastolic pressure is low preoperatively. With clamping of the ductus, both the systolic and diastolic pressures usually rise. Because of the carotid sinus mechanism, there is slowing of the pulse in response to the elevated blood pressure. If there is a marked bradycardia or a marked hypertension, the surgeon is asked to release the clamp temporarily and reattempt clamping the ductus in a few minutes. As soon as the patient adjusts to the altered hemodynamics,

the surgeon proceeds with dividing the patent ductus arteriosus.

Tetralogy of Fallot

I will skip over the Blalock and Potts procedures quickly, inasmuch as extracorporeal methods are used almost entirely at the present time in the treatment of tetralogy of Fallot. The Blalock procedure is an end-to-side anastamosis of the subclavian artery to the pulmonary artery and the Potts procedure is a side-to-side anastamosis of the aorta to the pulmonary artery. They are only palliative (compensatory) types of procedures and are not corrective. The corrective procedure is done using the extracorporeal methods.

During both the Blalock and Potts procedures, hypoxia and hypotension are the major problems facing the anesthetist. There is hemoconcentration in the range of 19-20 grams per cent hemoglobin in the usual tetralogy patient. One therefore tries to avoid the use of more blood, but fluids are used in an attempt to avoid the risk of thrombus formation due to the sluggish blood flow. An intravenous cutdown is essential in these patients for the same reason as in the patient for division of a patent ductus arteriosus, that is, in the emergency of unforeseen major hemorrhage.

Premedication can be heavier than is usual for children, to avoid unnecessary and undesirable struggling. Before induction, 100% oxygen should be administered. If the patient is very sick, oxygen is usually flowing on his arrival in the operating room. The critical point in either the Blalock or Potts operation is when the pulmonary artery is occluded for anastamosis. The blood pressure must be observed closely, because these patients are already cyanotic, with borderline cardiac reserve, and then suddenly one pulmonary artery is occluded which diminishes oxygenation even more. Once the anastamosis is completed, it is very important to keep the blood pressure high enough to keep flowing through the shunt, otherwise a thrombus can form at the site of anastamosis. If hypertension develops, it is wiser to use plasma than blood because of the hemoconcentration that is present.

Coarctation of the Aorta

In the management of the patient undergoing surgery for correction of coarctation of the aorta, close observation of the blood pressure is an absolute essential. Blood pressure observation is particularly important in these patients because there is an increased pressure in the cerebral vessels due to the lesion itself. With the occlusion of the aorta in preparation for resection of the stenotic segment, there may be an even greater increase in blood pressure. This additional increase in cerebral blood pressure can produce a cerebrovascular accident if it goes on unrecognized or untreated. Here also, as during the initial clamping of a patent ductus arteriosus, the surgeon should be asked to temporarily release the clamps, if the pressure rise is great, and try again in a few minutes. Occasionally, one may have to resort to the use of a hypotensive drug such as hexamethonium or Arfonad to reduce the blood pressure, especially if the lesion involves the left subclavian artery and the surgeon has to clamp it in order to perform the repair.

There are two critical times in the corrective procedures for coarctation of the aorta. The first is, as already mentioned, during occlusion of the

vessel. The second critical time is during release of the clamp after the repair. Release of the clamp frequently causes a marked blood pressure fall. One must be certain that blood replacement is adequate at this point and that more blood is readily available in the event that bleeding may be excessive from the site of anastamosis when the clamps are released. The second clamp is released slowly by the surgeon, and the anesthetist must observe the blood pressure very closely during this period. The blood pressure must then be constantly watched throughout the remainder of the operation. Bleeding may be extensive from the chest wall during the closure as a result of the increased intercostal artery pressure following removal of the stenotic segment of aorta.

The Pump Oxygenator

The usual cardiac lesions in which the pump oxygenator is used during surgery are tetralogy of Fallot, intra-atrial septal defect, intra-ventricular septal defect, pulmonary stenosis, aortic stenosis, and anomolous pulmonary venous return.

The premedication used is relatively light, consisting of a belladonna drug and Demerol in the range of 0.5 - 0.75 mgs. per pound of body weight.

On the morning of surgery, a catheter is inserted under fluoroscopy into the antecubital vein of the right arm and threaded up to the level of the superior vena cava. During perfusion this is used to monitor central venous pressure. The catheter is usually inserted under local anesthesia in the older children, but general anesthesia is usually required for the younger children. Nitrous oxide-oxygen-Halothane by mask has been very satisfactory. After the catheter is in place, the anesthetist uses it for the administration of drugs, fluids and blood until the patient is ready to be placed on the pump.

The patient is then taken to the operating room. Induction of anesthesia is usually performed with the patient on the guerney, using Pentothal, which is injected very slowly through the catheter, until there is loss of consciousness. Succinylcholine is then administered to permit easy, quick, intubation. Time loss during intubation must be minimal in these patients because of their poor cardiac reserve.

For several minutes before induction of anesthesia, the patient is allowed to breathe 100% oxygen in order to saturate the blood and tissues as much as possible with oxygen. After intubation, the succinylcholine is discontinued and anesthesia is maintained with nitrous oxide-oxygen (2:1) and Flaxedil. Supplemental Demerol and Pentothal are used as needed by injecting small increments at a time.

Hypothermia is used in conjunction with the pump-oxygenator in almost all of these patients. An ice water mattress on the operating room table will usually cool a child weighing less than 40 pounds to 30°C. in less than an hour. For heavier children, a heat exchanger is used in addition to the mattress, or in place of the mattress, to lower the body temperature. Use of the heat exchanger can cool even a 150 pound patient to 30°C. in less than 5 minutes.

Ice water is added to the mattress on the operating room table before the patient arrives from X-ray and

it is for this reason that the induction of anesthesia is done with the patient on the guerney. After he is asleep, the patient is then transferred onto the ice water mattress. By using this sequence, the patient can be cooling while the remaining preparations for actual surgery are being performed, i.e., connecting the electrocardiogram and electroencephalogram, insertion of an esophageal thermometer, catheterization of the urinary bladder, starting blood transfusion, and surgically scrubbing the patient from chin to knees, adjusting the lights, etc.

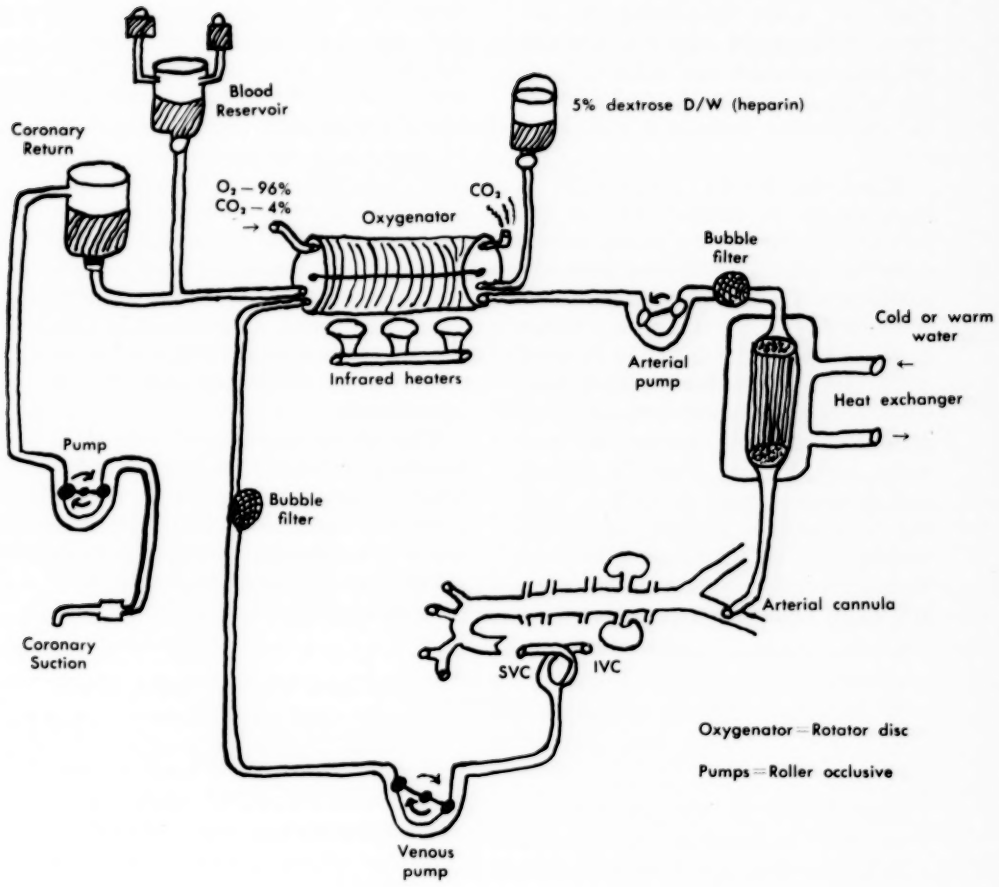
Administration of blood is started as soon as possible in anticipation of blood loss which occurs when surgery starts. Because fluid balance is very critical in these patients and overloading the circulation can be hazardous, it is very important to use the volume control blood filter sets and volume control intravenous sets. Use of the controlled volume bags prevents more than a desired safe volume to flow into the patient during a given period of time. Flaxedil in preference to succinylcholine drip is used as the muscle relaxant in the anesthesia management of these cases. This eliminates an additional factor in the fluid balance management.

It is very important in patients with intra-atrial or intra-ventricular septal defects to prevent even the smallest amount of air from gaining admittance to a vein. Such an air bubble can pass directly through the septal defect and go directly to the brain. Air emboli to the brain may produce brain edema with permanent damage or even death.

While the thoracotomy is being performed by one set of surgeons, two other surgeons are isolating the femoral veins and arteries in both inguinal areas. Into one femoral vein a catheter is inserted for administration of fluids, blood, and drugs throughout the remainder of the operation and for several days postoperatively. The arm catheter is then connected to a transducer to continuously monitor superior vena cava pressure. Into one femoral artery a catheter is inserted to continuously monitor arterial blood pressure; and into the other femoral artery the arterial cannula from the pump-oxygenator is inserted. By placing the arterial cannula from the pump into the femoral artery, the blood will course the aorta retrograde during the perfusion. It is unimportant that the blood flows backward up the aorta rather than downward so long as adequate blood pressure is maintained to perfuse the tissues adequately.

Because there is dilution of the anesthetic drugs in the patient's blood by the blood from the oxygenator when perfusion starts, the patient may awaken somewhat at this point. If this occurs, more drugs can be administered by injecting them into the arterial side of the oxygenator. In that way the drugs get to the patient immediately, whereas if they are injected intravenously into the patient, they must be picked up from the venous circulation, go through the vena cava, through the oxygenator and thence into the arterial side and back to the patient for distribution to the various tissues.

During actual perfusion, blood losses are replaced by the operator of the pump oxygenator. The anesthetist continues to ventilate the lungs during perfusion to prevent collapse and atelectasis.



A diagram of the circulation through the pump oxygenator and patient may show more clearly how the patient, oxygenator, and pumps are connected to each other.

The oxygenator replaces the patient's lungs and the pump replaces the patient's heart, so that in effect, the heart and lungs of the patient are "by-passed" and the patient's circulation is maintained outside of the heart or "extracorporeal."

When all cannulae are in place and the oxygenator cylinder and the tubes leading from the oxygenator to the patient are filled with blood, they are connected together.

The pumps are started and the patient's circulation is then maintained by the machine.

After the heart lesion has been corrected the patient is rewarmed by adding warm water to the water mattress. To speed rewarming the patient, warm water can run through the heat exchanger and infrared heating lamps turned on the underside of the oxygenator cylinder.

When the body temperature is back nearly to normal, i.e., in the 35°-37° C. range, the pump oxygenator is gradually slowed and the patient's heart allowed to resume its function, replacing the pump. When it is seen that the heart is in good condition and maintaining good tone, with adequate blood pressure and adequate rate and rhythm, the cannulae are removed from the patient and surgical closure is started. During the surgical closure, anesthesia usually can be maintained with nitrous oxide-oxygen only. Blood losses are again observed and replaced by the anesthetist during this phase of the operation.

When all wounds are closed, the patient's temperature back to normal, and consciousness is resumed, the patient is removed from the operating room to the intensive care unit where special duty nurses are on duty 24 hours daily for several days. Very close observation must be kept of the patient's electrocardiogram, venous pressure, arterial pressure, electrolytes, hemoglobin, input and output, respiratory exchange, breath sounds, and blood losses. It is essential that the slightest change in any of these things be recognized and treated immediately.

The whole sequence of events in handling patients undergoing open heart surgery, preoperatively, during operation, and postoperatively, is a much more closely integrated team effort than is seen in any other type of surgery.

Considerations in the Anesthetic Management of Abdominal Aortic Aneurysm (Sub-Renal)

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If one were comparing statistics of how many aneurysms were operated upon twenty years ago, and how many today, one might well conclude that aneurysm is a rather recent and modern ailment. Not so, however. It is true that the successful surgical management of aneurysms is a phenomenon of the past ten years, but medicine has been well aware of their existence for many centuries. In fact, a Second Century Greek by the name of Antyluss described aneurysms and their treatment.[1]

Aortic aneurysm has been picturesquely described as "an intra-abdominal time-bomb with an unknown length of fuse."[2] This description is actually quite literal, for until the past decade most aneurysms eventually just exploded, simply because there was no satisfactory treatment for them even though they were diagnosed. True, during the past many years, when surgical and anesthetic techniques had advanced far enough, attempts were made to prevent these fatal blow-outs. Those of you who have been around operating rooms for 15 to 20 years may have witnessed some of these earlier heroic efforts. The surgeon tried to wire the aneurysm, hoping to stimulate clot formation; or they tried using the wire to pass an electric current through it in an effort to produce thrombosis.

In the 1940's the idea was conceived, that, if the amount of fibrosis around the aneurysm could be increased, rupture could be prevented. To achieve this, cellophane or cutis grafts were wrapped around the aorta. All of these methods proved unsuccessful -- they did not produce fibrosis on the posterior aspect of the aneurysm, just where it was most needed.

In 1951, the first successful aortic resection and replacement with an homologous graft was achieved. This is essentially the surgical treatment in use today, except that the homologous graft has been replaced by the synthetic graft (such as crimped Dacron), which is available in many sizes.

The exact etiological mechanism of abdominal aortic aneurysm is not known. With few exceptions, however, aneurysm of this type is associated with, and probably caused by, arteriosclerosis. According to DeBakey,[3] "the essential factor is damage to the medial elastic coat of the

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vessel. Only the outer adventitious layer remains to withstand the repeated force of systolic impact. Once this medial disruptive process has occurred, progressive dilatation ensues at the weakened area, and pressure is exerted on the surrounding tissues." In at least 90% of the untreated cases, this dilatation continues until rupture occurs, and, if still not treated at this stage, the patient usually exsanguinates.

These aneurysms have been found to occur seven times more frequently in males than in females, and since this is a disease associated with arteriosclerosis, it is not surprising to find the highest incidence of this disease in males in the mid-sixty age group. Alarmingly, of the patients with aneurysm, at least 50% also have other associated serious cardiovascular disease.[1]

The age-group of these patients, and their associated diseases, do not make them seem to be very desirable candidates for extensive elective surgery. However, compare these mortality figures: When abdominal aortic aneurysms are not treated surgically, the mortality is greater than 90%; when they are treated electively before rupture, the operative mortality has been decreased to less than 10%. Even those patients who are brought to the operating room with their aneurysms ruptured have a 50% chance for survival. The known risk of surgery (10%) compared with the almost certain death from the untreated aneurysm (90%) produces the philosophy that if the patient does not have an otherwise fatal disease, the mere presence of an abdominal aortic aneurysm is indication for its removal and replacement with a graft.[2] This is the only effective treatment.

ANESTHESIA

When considering the anesthetic management of the elective abdominal aortic aneurysm patient, there are various basic problems that must be antcipated: First of all, the patient will most likely be between 60 and 70 years old; he will be arteriosclerotic; he will be hypertensive — this last factor is almost uniformly present.[6] In addition, he probably has other serious cardiovascular disease—perhaps coronary insufficiency with a previous history of myocardial infarction. He probably also has some form of chronic respiratory disease, e.g., emphysema, etc.

At the risk of seeming trite, the anesthetist's responsibilities can be itemized as follows: (1) Put the patient to sleep, (2) Establish an adequate airway, keep the patient oxygenated and ventilated; (3) keep the patient relaxed, (4) maintain the patient's blood pressure, and (5) wake the patient up!

As with any anesthesia for any case, there is no such thing as a one and only perfect agent for use with aortic aneurysms. Any agent, or combination of agents, with which the individual anesthetist can maintain a light plane of anesthesia, with maximum relaxation and oxygenation, and which does not cause undue interference with the maintenance of blood pressure, can be deemed the agent of choice.

At the Veterans Administration Hospital, San Francisco, the most frequently used agents for these procedures have been Pentothal-Anectine combination for induction of anesthesia and tracheal intubation, and then N_2O combined with a narcotic and relaxant for maintenance. Cyclopropane combined with relaxant has also proven quite satisfac-

tory. Our philosophy has been that by combining the inhalation agents with the relaxants we have been able to maintain lighter planes of anesthesia and thus have fewer problems with cardiac depression and with blood pressure fluctuations.

Relaxation is, of course, mandatory for exposure in these procedures, but generally, just the extent of the incision (xiphoid to pubis) relaxes the belly wall masculature to such an extent that massive adjuvant drug or anesthetic relaxation is not usually demanded. Once the retractors are in and the bowel packed away, a minimal depth of analgesia and relaxation will suffice.

VENTILATION

There should be no anesthetist who needs a discussion, or even a reminder, of the values of oxygenation and ventilation. This is, of course, the prime obligation of the anesthetist regardless of the type of surgical procedure, or of the condition of the patient involved. However, in the patient who is going to have his aorta clamped off and resected, it must be realized that various parts of the circulation are going to be interrupted, and for varying periods of time. The survival of some of the tissues may well depend on their oxygen saturation. We generally use some sort of mechanical respirator on these patients, (a Jefferson, and more recently, a Bird), for two main reasons: First, it obviates the 'tired hand' syndrome on these lengthy operations; secondly, the extra two hands thus freed are usually much in demand later on when the blood starts flowing and massive, rapid replacement is essential.

To reiterate, these are going to be patients who are starting out with cardiovascular and respiratory handicaps; their tolerance of any compromise on oxygenation or ventilation is going to be minimal and it is the responsibility of the anesthetist to see to it that these patient's needs are provided.

BLOOD PRESSURE

Granted, ventilation is a very vital consideration in the management of any anesthetic case. In addition, and in vascular work in particular, the maintenance of adequate blood pressure values can be the decisive factor in the survival or demise of these patients. Remember, these are arteriosclerotic, hypertensive patients to begin with, and their compensatory mechanisms will most likely not accommodate readily to gross changes in the circulating blood volume. Our routine in the handling of these cases has been to insert two large-bore needles, or catheters (usually size 14) before induction of anesthesia; these in addition to the needle (size 18) used for administration of anesthetic drugs or vasopressors. It is important that these intravenous routes be in the upper extremities so that they are within convenient reach of the anesthetist at all times.

Before starting the anesthetic, we have found it advisable to have a vasopressor drip solution mixed and hooked up ready for immediate use. Our preference is a Neosynephrine solution (0.002%). Generally, it is not necessary to use vasopressors until just before the aortic clamp is to be removed, and then it is our policy to start the vasopressor routinely, regardless of what the blood pressure may be. When the aorta is clamped, the tissues distal to the clamp are going to be deprived of oxygenated arterial blood and the resultant local

tissue hypoxia will cause a peripheral vasodilatation. The rationale for the routine use of the vasopressor is to constrict this dilated peripheral vascular bed prior to the unclamping of the aorta. With the vasoconstriction thus achieved it is felt that less blood will suddenly be required to fill the vascular system when the aorta is unclamped. Before unclamping the aorta, blood is, of course, ready for massive and rapid replacement as it is needed. If the surgeon releases the aortic clamp slowly and deliberately, the circulatory responses are usually manageable with the use of blood replacement and vasopressors.[7] These are the really tense and critical moments in aneurysm surgery — this is the time when extra hands or assistants are essential.

A word here about over-transfusion. There seems to be no really accurate and practical method for measuring blood loss during surgery and yet accurate blood replacement is so important to these patients. One clue, suggestive of over-transfusion, is an increased venous pressure which the anesthetist will recognize by the appearance of distended neck veins.

RUPTURED ANEURYSM

So far, this discussion has been concerned with patients having aortic abdominal aneurysms which are intact; patients who come to the operating room on a more or less elective basis with thorough medical and surgical evaluation preoperatively. And even though these patients are probably never classified as "good" risks, at least the anesthetist knows beforehand just about what the physical status of that patient is.

With fair frequency, in recent years, patients with ruptured aneurysms are being treated surgically and these are the really emergency cases where the time factor alone may determine whether or not the patient survives. In these people, hemorrhage may be profuse and death occur within minutes; some live for hours or days after the onset of retroperitoneal bleeding. The aorta is retroperitoneal, and the ruptured aneurysm may be contained by the peritoneum for a variable period of time. In any case, when the peritoneum is ruptured by the enlarging hematoma, fatal issue is at hand.[5] The surgical attitude toward these cases of ruptured aneurysm is, that an attempt at resection is made in all instances, regardless of the almost apparent hopelessness of the situation.[4] These patients are going to bleed to death—surgical intervention is their only chance. Without surgery the mortality is 100%; with surgical intervention there is a 50% chance for survival! Some of these seemingly moribund patients make a remarkable recovery on the operating table after the aorta is clamped and blood volume is restored.

When the diagnosis of ruptured aneurysm is made, the patient is taken to the operating room immediately. There is no time for elaborate laboratory procedures. A brief history is obtained and a brief physical examination is made. A urinalysis, blood count, typing and cross-matching must suffice in most instances. The patient will most likely be in shock and in severe pain if he is still conscious; he may or may not have an audible blood pressure or palpable peripheral pulse.

The first step on the patient's arrival in the operating room is usually to perform two cut-downs and as soon as these are satisfactorily established, the anesthesia is started. It is

of utmost importance that anesthesia induction and tracheal intubation proceed without straining — any increase in intra-abdominal pressure may cause death. So many of these patients are moribund by the time they get to the operating room and most of them will not withstand massive assault with any premedicant or anesthetic drug or agent, and yet it is up to the anesthetist to avoid any straining or bucking or coughing or struggling.

Sometimes it is desirable to intubate these patients while they are awake; sometimes topical spraying or transtracheal anesthesia is used, but this frequently causes coughing if the patient is conscious. It is perhaps even justifiable and good practice to paralyze these patients with relaxant for the intubation and then proceed with the induction of anesthesia. As inhumane as this may seem, patients in this critical state usually have a retrograde amnesia for most of the events occurring long before arrival in the operating room. Sometimes even a one or two cc. of intravenous barbiturate will suffice for a "sleep dose" in these patients and permit a more esthetic approach to the smooth intubation and induction.

Blood is started as soon as it is available and once the abdomen is open the anesthetist can begin to get an estimate of the blood loss which has occurred and manage the replacement accordingly. Once the aorta is clamped and the bleeding under control, the handling of the ruptured aneurysm case is much the same as for the elective procedure.

COMPLICATIONS

As one might anticipate, post-operatively, the complications most frequently encountered in patients who have undergone aneurysm surgery are those related to the cardiopulmonary systems. Some of these problems can indeed be avoided by good surgical and anesthetic management. For example, acute coronary occlusion is usually associated with a period of hypotension, and as was stressed earlier, the maintenance of blood pressure and blood volume are certainly in good part a responsibility of the anesthetist. Congestive heart failure or postoperative coronary occlusion are also statistically significant complications in these patients, and these have been found to occur most frequently in those with a history of myocardial infarction with diminished cardiac reserve.

The patient who survives the surgery for a ruptured aneurysm, faces the additional hazards resulting from the periods of shock to which he has been subjected before he came to surgery. In addition to the cardiac arrhythmias associated with the hypotension, inadequate filling of the heart and subsequent cardiac anoxia, these people are candidates for anuria —lower nephron nephrosis—also as a result of their prolonged and often profound shock. Because of the many chronic respiratory diseases common to this aneurysm age group, one can also predict a high postoperative incidence of atelectasis and pneumonia due to retained bronchial secretions. A prophylactic tracheotomy is indicated if there is any doubt as to the patient's status in this respect.

I feel certain, that when someone discusses this same topic again five years from now, some of the anesthesia techniques I have described today may well seem obsolete. And, that is perhaps desirable — anesthesia as a science must change and progress.

The basic physiologic concepts, however, of airway maintenance, oxygenation, ventilation and maintenance of blood pressure, will be in vogue much longer.

SUMMARY

A brief review of early surgical attempts in treating abdominal aortic aneurysm is presented. Etiology of abdominal aneurysm is unknown; it is associated with arteriosclerosis. The pathogenesis is considered to be damage to the medial elastic coat of the artery. Abdominal aortic aneurysm occurs most often in males in the 60-70 age group. If untreated, the mortality is between 90 and 100%; intact aneurysm with surgical intervention has a mortality of 10%; ruptured aneurysm with surgery, a mortality of 50%.

The anesthetic management of abdominal aortic aneurysm is discussed. The choice of agents is wide. The requirements are: A light plane of anesthesia, good relaxation, high oxygen concentrations, adequate airway and ventilation, accurate blood replacement, and maintenance of blood pressure. The routine use of vasopressors prior to the release of the aortic clamp is proposed.

The importance of smooth induction and tracheal intubation for the patient with ruptured aneurysms is stressed. The most frequent postoperative complications (cardiopulmonary and renal failure) are briefly reviewed.

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The THIRTY-FOURTH QUALIFYING EXAMINATION for membership in the American Association of Nurse Anesthetists will be conducted on November 18, 1961. The deadline for accepting completed applications including the transcripts is October 9. Notice of eligibility will be mailed about October 16.

Applications should be forwarded early enough to allow time to request transcripts and have them returned to the Executive Office before the deadline date.

The THIRTY-FIFTH QUALIFYING EXAMINATION for membership in the American Association of Nurse Anesthetists will be conducted on May 12, 1962. The deadline for accepting completed applications including the transcripts is April 1. Notice of eligibility will be mailed about April 9.

Applications should be forwarded early enough to allow time to request transcripts and have them returned to the Executive Office before the deadline date.

The Transmission of Impulses

Helen P. Vos, B.S., C.R.N.A.*
St. Louis, Mo.

For centuries man has known and discussed the reflex. Touching a hot surface caused the muscles of the arm to contract and removal of the fingers from the hot surface. This was loosely described as "conduction through afferent and efferent pathways." Then came the muscle relaxants. As is often the case, these drugs were in common use before their action was truly understood. They were thought to interrupt conduction. A few concluded that this interruption occurred somewhere in the afferent pathway as well as in the efferent pathway, or perhaps more correctly, the muscle relaxants were central nervous system depressants as well.

In 1946, Dr. Scott M. Smith,[1] subjected himself to a noble experiment. He was given d-tubocurarine without anesthesia for the purpose of testing the cerebral effect of the drug. Signals for communication had been prearranged. Accurate recordings of the electroencephalogram and electrocardiogram were made. Pulse, blood pressure, respiration, etc. were to be recorded. The total dose was 500 units of d-tubocurarine in 33 minutes. Dr. Scott reported that he had been conscious throughout the entire period of total paralysis. Senses of pain, hearing and smell were unimpaired. This experiment gave proof that d-tubocurarine is not a stimulant, has no depressant or analgesic properties and has little effect on smooth muscle, for there was no untoward effect on the cardiovascular system.

Experiments finally pinpointed the effect of muscle relaxants at the junction of the efferent nerve fiber and the muscle cell, namely, the myoneural junction. But why? In rushed new ideas and theories, many confusing and conflicting, but here and there a few facts came into being. Much of the discussion in this paper is still of a hypothetical nature.

Since World War II, we have been able to measure and observe ionic movements and activity. Discussions and views concerning the transmission of the impulses are as interesting to read as a drama. Drama must have characters, and in this instant, our characters are ions. Each ion has its own personality and characteristics, has its own normal habitat and needs a certain number of its own kind to do its work. At times it may have the problem of overpopulation, leaving some loafers who make trouble; at other times there may be

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Presented at the Mid-South Post-Graduate Assembly of Nurse Anesthetists, Memphis, Tennessee, Feb. 16, 1961.

an insufficient number to perform the work expected of them. In order to begin this drama we must first set the stage, that is, the human body.

ION CONCENTRATION

We have two biological compartments to consider; the extracellular and intracellular. The extracellular consists of plasma and interstitual or tissue fluid, and the intracellular found within the body cells. Electrolytes inhabit both compartments. Electrolytes are compounds whose aqueous solutions will conduct an electric current.[3] A common example would be a salt dissolved in water. Salt, in crystal form, is made up of sodium (Na) which has a positive charge, and chlorine (Cl) which has a negative charge. Since opposites attract each other, the salt crystal consists of Na^+Cl^-. When placed in water, each molecule of Na^+Cl^- will dissociate and give the solution one positive (+) and one negative (—) charge. These charges are called ions. The word means wandering. The Na^+ ions and Cl^- ions are free to "wander" independently if the semipermeable membranes will permit. The same may be done with other salts, such as potassium chloride (K^+Cl^-) and calcium chloride ($Ca^{++}Cl_2^-$).

Returning to the body compartments we find that Na^+ is predominantly outside the cell, and K^+ is predominantly inside the cell. (Fig. 1.) These ions have corresponding negative charges.

In this discussion concerning the transmission of impulses we follow the movements of Na^+ and K^+ and merely state that they leave their negative charge, usually Cl^-, in its former location.

CELL MEMBRANE POTENTIAL

The cell membrane is very selective, permitting some ions to pass through and rejecting others. This is called permeability or semipermeability. Since the concentration of K^+ is greater on the inside of the membrane, the bombardment of the kinetic motion is from the inside toward the outside. The membrane is somewhat permeable to K^+ and permits some to escape. Therefore, a negative charge is left inside the cell and the positive charge is outside the cell membrane. Na^+, in the meantime, is bombarding from the outside

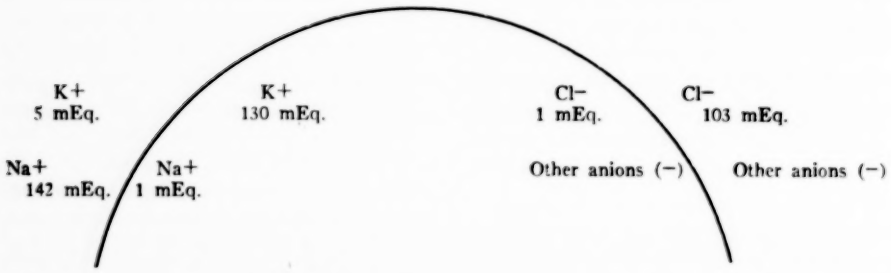

Fig. 1 Schematic representation of ion concentration in extracellular and intracellular compartments.

toward the inside, but the membrane is normally impermeable to Na^+ and it is not permitted to enter. K^+ is the ion which gives a normal cell its power or potential. All body cell membranes have this potential.[4]

NERVE FIBER POTENTIAL

The nerve fiber has a potential exactly the same as that described for the body cells which would include the nerve cell. When the nerve cell is in a state of polarity, or at rest, the nerve fiber is in a state of polarity as well. This may be represented as shown in Figure 2.[4]

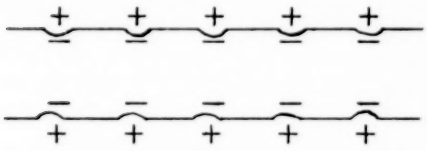

Fig. 2 Membrane in normal resting state and is said to be polarized.

When a stimulus reaches the cell body its membrane becomes more permeable and more ions are permitted to pass through. The Na^+ is now able to diffuse from the outside (high side) to the inside of the cell and some of the inside K^+ will go extracellular as well. As the Na^+ diffuse interiorly, they will leave a negative charge outside the cell and there is now an exchange. This also occurs along the nerve fiber. This membrane is now depolarized and may be represented as shown in Figure 3.

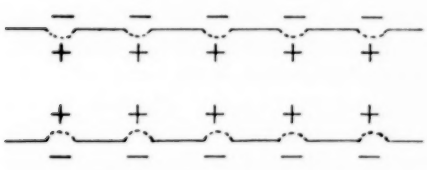

Fig. 3 Conduction of an impulse by depolarization.

Depolarization may spread in either direction and goes to completion, thereby transmitting an impulse. Anything capable of increasing the permeability of a membrane permits depolarization. Some examples would be:

1. chemicals and drugs
   a. acetylcholine — found in the body
   b. acids or alkalines
   c. anesthetic drugs
2. an electric current
3. mechanical stimuli: pricking, crushing, burns, trauma or anoxia.

Depolarization lasts about 1/2500 of a second. Membranes are eager to return to the "resting state," therefore, repolarization follows quickly. In fact, depolarization is normally only about 5 cm. ahead of repolarization. (Fig. 4.)

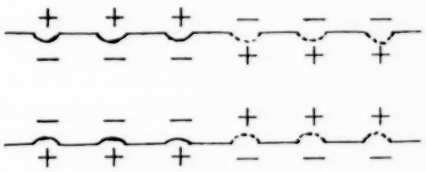

Fig. 4 The repolarization of a depolarized membrane.

If depolarization is permitted due to the activation of acetylcholine, then repolarization occurs due to the destruction of acetylcholine by an enzyme of the body named cholinesterase. After repolarization is complete the cell is again in the polarized state and is ready for another impulse. Whenever muscle is kept in the contracted state this cycle keeps repeating itself until the impulse is removed. A nerve fiber can carry 2500 impulses a minute.

Nerve cells, or any cells, cannot receive an impulse while in the depolarized state. The **absolute refractory period** is the time during depolarization and before repolarization when the nerve cannot accept a stimulus. A **relative refractory period** occurs during repolarization. An impulse may be accepted but will do so less readily.[4]

NEUROMUSCULAR TRANSMISSION

The nerve fiber apparently does not penetrate the muscle cell but ends in the sarcolemma, leaving a subneural space. The motor endplate, with its cholinergic receptors, forms the membrane potential for the striated muscle.[5] Acetylcholine is found here as well and in the resting state is bound to proteins, therefore, inactive. (Fig. 5.)

A stimulus to a nerve cell will begin depolarization of the cell and continue to depolarize the nerve fiber. When it reaches the myoneural junction, the acetylcholine is activated and increases the permeability of the motor endplate and the cholinergic receptors permit depolarization of the muscle cell. Contraction of the muscle fiber results. (Fig. 6.) However, repolarization begins almost immediately in the nerve cell, the nerve fiber and at the motor endplate as well. As stated before, if the muscle is to be kept in the contracted state, this cycle of stimulus—depolarization—repolarization—polarization and stimulus, must keep repeating itself. Interruption anywhere in this cycle will discontinue the contraction. The usual interruption is removal of the stimulus, but during the use of muscle relaxants we may prevent depolarization, or with some prevent repolarization and cause paralysis. More about this later.

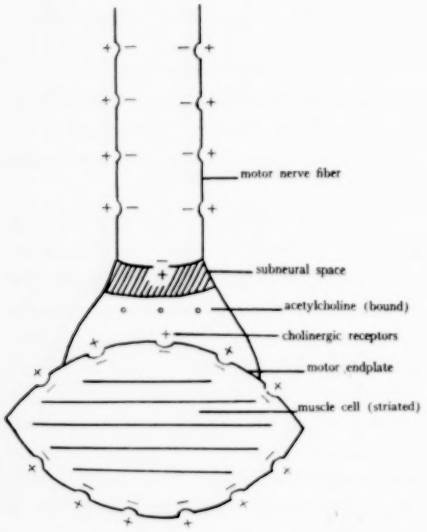

Fig. 5 Neuromuscular or myoneural junction.

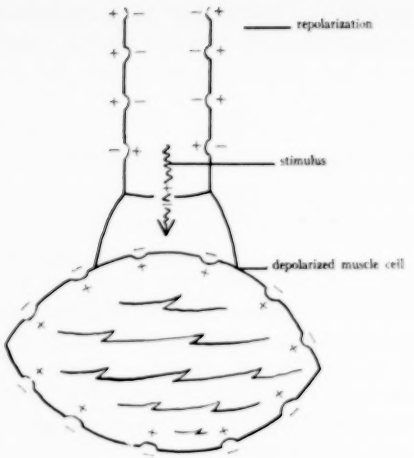

Fig. 6 Depolarization of muscle cell causing contraction of muscle. Repolarization follows immediately.

It is only fair to state that more recent investigations are revealing that the transmission of the impulse at this junction is much more com-

plicated than here stated. There are perhaps five layers between the neuron and the muscle fiber but the function of each is still obscure. The mode of transmission is often called the "acetylcholine system" and according to the explanation given above, it applies very well indeed. However, acetylcholine, with cholinesterase as well, is found in synaptic junctions in ganglia of sensory neurons as well, but drugs do not always affect all areas in the same manner. For our purpose today, we will continue to assume that activated acetylcholine increases the permeability of the motor end plate, permitting depolarization of that muscle fiber and that cholinesterase quickly hydrolyzes the acetylcholine to acetic acid and choline.

THE MYONEURAL JUNCTION

The myoneural junction is an all-important link in normal physiology. The same may be said of the junction between two neurons, *viz.*, the synapse in the various ganglia of the nervous system. Some interesting observations regarding the myoneural junction bear mentioning.

1. Fatigue of the junction occurs more readily than nerve cell or fiber fatigue.[2]
2. Normally the transmission of impulses across the junction goes in one direction only.[2]
3. Compounds may depress impulses at this junction, or they may encourage the muscle to respond more readily.[2]
4. The junction is more sensitive to chemical changes in the body.
5. Reduction of body temperature retards conduction of the impulse here as well as along the nerve fiber. This is probably due to rapid changes of blood electrolytes.[6]
6. Magnesium blocks transmission at the junction, whereas calcium probably acts in an antagonistic way toward the magnesium.[6] A decrease in Na^+ concentration blocks transmission as well. An excessive amount of K^+ may first cause depolarization but if not corrected or balanced by other ions will cause neuromuscular block.[7]
7. In man, most muscle relaxants exert their effect at the motor endplate and produce no alteration in the transmitting of impulses along the nerve fiber.[6]

MUSCLE RELAXANT AND THE MYONEURAL JUNCTION

This discussion permits mention of only a few of the muscle relaxants and their effects at the myoneural junction. We shall briefly mention d-tubocurarine, gallamine (Flaxedil), decamethonium (Syncurine) and succinylcholine (Anectine).

The cholinergic receptors of the motor endplate seem to have an affinity for d-tubocurarine, and are probably held there. This does not give acetylcholine access to the receptors and depolarization is not permitted. Due to this effect, d-tubocurarine is said to be a non-depolarizing or competitive relaxant. Gradually the concentration of d-tubocurarine is redistributed to all parts of the body, partly destroyed (site unknown) and partly eliminated in the urine.[8] This accounts for the duration of action.

Gallamine is also a non-depolarizing agent. It is eliminated much the

same as d-tubocurarine but may be somewhat shorter acting.[5]

Decamethonium, when it reaches the myoneural junction, also goes to the cholinergic receptors and competes with acetylcholine for them. Decamethonium, however, acts like acetylcholine and permits depolarization. The depolarization is persistent and does not permit repolarization and, since the normal cycle of transmission is interrupted, the muscle cannot receive another stimulus and relaxation exists. This drug is classified as a depolarizing drug.[5] This agent is also redistributed throughout the body and partly eliminated in the urine.

Another depolarizing drug is succinylcholine but its fate makes it a worthwhile drug to mention. Succinylcholine, if thought of as containing two atoms of choline, undergoes rapid hydrolysis by the plasma cholinesterase. This plasma cholinesterase is often referred to as pseudocholinesterase in contrast to true cholinesterase which is found in the red blood cell. The hydrolysis occurs in two stages. The succinylcholine is rapidly changed to succinyl*mono*choline and choline at the myoneural junction. This accounts for the short acting effects of succinylcholine. However, the succinylmonocholine is still present. Its hydrolysis to succinic acid and choline occurs much more slowly and apparently is accomplished by an esterase contained in the liver.[8] Succinylmonocholine is also a muscle relaxant of sorts, probably being of the non-depolarizing type. If excessive amounts of succinylcholine have been given and the liver has been unable to break down the succinylmonocholine, it accumulates and the neuromuscular block is changed from a depolarizing block to a non-depolarizing block. The change from a depolarizing block to a non-depolarizing block is often referred to as a dual block.[6]

SUMMARY

Opinions and theories concerning the transmission of the impulse from neuron to neuron and from neuron to muscle cell are still varied. Many are based on admirable investigation and research. They are helpful to us in our attempt to understand the effect of drugs, disease, electrolyte imbalance and mechanical stimulation on the normal human body. The theories presented in this paper may be obsolete tomorrow. The process of depolarization, repolarization followed by the state of polarity has been accepted by most. The transmission at the myoneural junction is still aggitating the investigators. The role of acetylcholine at the junction is questioned by many.

A few statements concerning some of the muscle relaxants were used mainly to illustrate their blocking effect at the myoneural junction.

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10/61

Legislation

Emanuel Hayt, LL.B., Counsel A.A.N.A.

Hospital and Nurse Anesthetist Not Responsible for Death of Maternity Patient

In an action by a husband as administrator of his deceased wife's estate, to recover damages for her wrongful death, claimed to have been caused by the malpractice of the two individual defendants, Abraham Prostkoff, a doctor-obstetrician, and Bessie Flora Evans, a nurse anesthetist, in the defendant hospital's employ, the jury after trial rendered a verdict in favor of the plaintiff against the doctor in the sum of $60,000, and in favor of the nurse and the hospital against the plaintiff.

The nurse and the hospital appeal from an order of the Supreme Court, Kings County, dated September 8, 1959, which granted plaintiff's motion to set aside the jury's verdict in their favor, severed the action as against them and restored it to the calendar for a new trial.*

On April 28, 1955, at about 10.04 A.M., within two minutes after plaintiff's wife had delivered her child in the hospital's delivery room, she expired while being attended by the doctor and the nurse. That morning, prior to her entry in the hospital, a rupture of the sac of amniotic fluid protecting the fetus had occurred. Examination by the doctor prior to delivery showed that the child was in distress. At his direction, straight oxygen was administered through a mask for ten minutes from 9:45 A.M. Then a combination of nitrous oxide and oxygen was administered up to the time of delivery at about 10:02 A.M. During the final two minutes prior to delivery, ether was administered.

Defendants undertook to show that the cause of death was the clogging of capillaries in the lung by material contained in the amniotic fluid, which had entered the bloodstream through venous sinuses in the wall of the uterus; and that this was a rare but recognized embolism which had occurred despite their observance of standard practice.

Plaintiff claimed that his wife had choked to death. He offered testimony of a surgeon, who specialized in trauma cases, as to methods of washing the stomach, inserting tubes in the stomach and trachea for the vomit, and administration of the anesthesia, which would have avoided the alleged aspiration of gastric contents into the windpipe.

Pathologists and the then assistant medical examiner of New York City testified for the defendants, primarily on the basis of microscopic findings after autopsy and on slides of sections of lung tissue, that the embolism was the cause of death. The court concluded that this testimony

* Ed. Note: The original decision and opinion, which has now been reversed by the Appellate Division, was written by Mr. Justice Louis Friedman.

and the exhibits in support thereof had been fabricated. In our opinion, such conclusion was not only based on an erroneous misconception of the proof in the record, but it was immaterial in any event because by their verdict the jury had rejected embolism as the primary cause of death.

Nor can the verdict be deemed inconsistent because it was rendered against the doctor and in favor of the nurse. The jury could have found that the doctor was derelict in matters of judgment which were exclusively his concern, whereas the nurse adequately performed her limited duties without notice to her of asphyxiation. The court charged, without exception, that the jury could find (as it did) for the plaintiff and against the doctor but not against the nurse and hospital.

Under all the circumstances, it is our opinion that the verdict in favor of the nurse and the hospital should not have been set aside.

Order reversed, with costs, plaintiff's motion to set aside the jury's verdict in favor of the nurse and the hospital denied, and the jury's verdict in their favor reinstated.

(Weinstein v. Prostkoff, et al., App. Div., Second Dept., N.Y.L.J., March 21, 1961, p. 14, col. 3-4.)

Negligence of Nurse Held Cause of Patient's Fall Over Electric Light Cord

There is evidence tending to show that defendant was running a nursing home for aged people and contracted to give full-time nursing care to the plaintiff. The plaintiff was ninety-four years of age, a feeble woman who went to the defendant's home from a hospital on a stretcher. The defendant being aware of plaintiff's infirmities and agreeing to give her nursing care, certainly assumed an obligation to exercise care commensurate with plaintiff's physical condition. In fact the defendant stated that it was her job to protect and care for those in her custody. According to her own testimony, "They are like babies," and further, "I don't get them until they are (feeble) or until they get where they can't help themselves."

An electric light cord was allowed to lie loose upon the floor of a room occupied by a woman ninety-four years old, in an area which was used frequently for many purposes. It was left to lie loose in a pathway utilized by the plaintiff, with the defendant's knowledge and consent, among other things, to have access to her commode stool and also to adjust draperies on the windows. There was a failure to use a few brads or nails to affix the light cord to the baseboard and so out of the pathway of the plaintiff. There was a failure to remove the plug for the light cord from a position in the floor five inches away from the baseboard to the accepted place on the side of the baseboard.

On the date of the accident the plaintiff arose from her sleep, ate breakfast, rested some, took the medicine offered to her by the defendant, lay down for a while and then, having noticed some men on the porch, got up to insert a pin in the curtains in order to close a crack in the curtains, after which she started back to her bed and fell. According to the plaintiff's testimony she was feeling well but caught her foot in the wire which "threw me." She stated that her foot got tangled in the cord and she slipped. She stated that it must

(Continued on page 303)

Book Reviews

The Putnam Medical Dictionary. By Norman Burke Taylor, V.D., M.D., F.R.S., (Canada), F.R.C.S. (Edinburgh), F.R.C.P. (Canada), M.R.C.S. (England), L.R.C.P. (London), Formerly Professor of Physiology, University of Toronto, and of The History of Medicine, University of Western Ontario and Allen Ellsworth Taylor, D.S.O., M.A., Classical Master, St. Andrew's College, Aurora, Ontario. G. P. Putnam's Sons, New York. Cloth. 933 pages. 1961. $4.95.

In reviewing a dictionary, the reviewer is dependent on "spot-checking." This small book (less than 7 x 5 inch pages) stands up well under rather extensive spot-checking. In addition to the A to Z listing of words, there are more than 150 pages of tables and lists.

Among the useful facts found in these "extras" which will be of value to anesthetists are a list of medical gas cylinder identifications, normal ranges of values for blood, urine, and cerebrospinal fluid tests, abbreviations for medical and allied association names, weights, measures, and many others.

Basic Pharmacology for Nurses. By Jessie E. Squire, B.A., R.N., M.Ed., Instructor, Hayward-Fairmont School of Vocational Nursing, Hayward Adult and Technical School, Hayward Union High School District, Hayward, Calif. The C. V. Mosby Company, St. Louis, Mo. Paper, 275 pages, 2nd ed., 1961. $3.50.

Designed for teaching pharmacology to student nurses, the book contains basic information about certain drugs, dosages, measurement, and common uses. The role of the nurse in handling drugs, the responsibilities and limitations of nurses in this field, and suggested practice sessions are among the many facets briefly covered. Questions and review assignments, a glossary, index and a review of legislation pertaining to drugs are incorporated in the book.

Principles and Technics of Rehabilitation Nursing. By Florence Jones Terry, B.A., R.N., P.T., O.T., Board Member, The Rehabilitation Center of Greater St. Louis, St. Louis; Gladys S. Benz, R.N., M.A., Chairman, Department of Maternal and Child Nursing, State University of Iowa, College of Nursing, Iowa City; Dorothy Mereness, R.N., A.B., M.N., Ed.D., Director of the Program, Psychiatric-Mental Health Nursing, New York University, School of Education, New York; Frank R. Kleffner, Ph.D., Assistant Director, Division of Speech Correction and Pathology, Central Institute for the Deaf, St. Louis and Deborah MacLurg Jensen, R.N., M.A. (Editor) The C. V. Mosby Company, St. Louis, Mo. Cloth, 344 pages, 2nd ed., 1961. $6.00.

The question might well be asked, "Why should this book be reviewed in a journal for anesthetists?" After reading the book, the reader may better ask, "Why is this not required reading for anesthetists?" There is so much information that can be used by anesthetists in handling patients that no review could list them all. A few of the subjects will illustrate the potential for the anesthetist: Points in dealing with blind persons; the aged person with health problems; the child with a handicap; growing through illness and aids to ambulation.

Abstracts

Carfagno, S. C. and Magee, J. T.: Granulocytopenia due to chlorpromazine: a report of 11 cases. Am. J. M. Sc. 241: 44-53 (Jan.) 1961.

"The occurrence of granulocytopenia as a complication of therapy with chlorpromazine (Thorazine) has been well established in the literature. . . . The mechanism by which chlorpromazine produces granulocytopenia is unknown. . . . [In] eleven cases of granulocytopenia due to chlorpromazine therapy . . . it was found that the duration of therapy and size of dose varied and was not necessarily a factor in the production of granulocytopenia. The clinical picture was characterized by fever, pharyngitis and prostration. Two cases presented with pneumonitis and one with an acute abdomen. Therapy consisted of general supportive measures, antibiotics, steroids and blood. Seven of the 11 cases survived. We were unable to correlate the survival with any specific factor in therapy."

Burn, J. H. and McDougal, D. B., Jr.: The effect of reserpine on gangrene produced by thiopental in the mouse tail. J. Pharmacol. & Exper. Therap. 131: 167-170 (Feb.) 1961.

"The mechanism of gangrene production after accidental intraarterial thiopental injection is not understood. . . . Gangrene has been produced in the tails of mice by the subcutaneous injection of thiopental into the tail. The effect of reserpine upon the lesion has been studied. Although the injections were not intraarterial, the results may have a bearing on the problem of thiopental-induced gangrene in man. . . .

"When thiopental is injected into the subcutaneous tissue of the mouse tail, cyanosis and gangrene occur between the site of injection and the tip of the tail. Necrosis and ulceration occur at the site of injection. Injection of mice with reserpine delayed the development of gangrene and reduced the incidence of necrosis and ulceration."

Hartman, M. M.: Reduction of maintenance doses of prednisolone in bronchial asthma by the concurrent use of hydroxyzine. Ann. Allergy 19: 55-66 (Jan.) 1961.

"The present investigation has two main purposes: Purpose 1: To ascertain the actual extent to which the prednisolone maintenance requirements in various types of bronchial asthma can be reduced by the concurrent administration of hydroxyzine. Purpose 2: To compare the relative effectiveness of hydroxyzine, meprobamate, and phenobarbital for reducing such maintenance requirements. Phenobarbital was selected because it was representative of a group of compounds which have been standard sedatives for decades. Meprobamate is a widely-used tranquilizing agent of recent vintage. . . .

"When significant conscious or unconscious emotional factors are present in asthmatic patients, the concurrent administration of hydroxyzine allows an appreciable lowering of

prednisolone maintenance requirements. Hydroxyzine is a desirable adjuvant for allaying the anxiety factor in prolonged severe asthma.

"The use of hydroxyzine in indicated cases usually allows reduction of daily dosage of prednisolone to 15 mg. or less, thus avoiding the range in which the more serious complications of gluco-corticoid medication are most frequent. Hydroxyzine allows a lower prednisolone maintenance dose in indicated cases than either meprobamate or phenobarbital."

Kurtzke, J. F.: The use of cyclohexylamines in thalamic pain. Neurology 11: 390-394 (May) 1961.

"The thalamic syndrome of Dejerine and Roussy is characterized by contralateral motor and sensory disturbances due to lesions involving principally the posteroventral and ventrolateral thalmic nuclei and internal capsule; the resulting dysfunction includes hemiparesis, hemiataxia, hemisensory defect, and most strikingly, 'thalmic pain.' This last consists of an exceedingly unpleasant continuous painful state, usually described as burning, plus dysesthesia —spreading, poorly localized exacerbation of the pain in response to tactile or noxious stimuli. . . .

"In September 1958, Greifenstein and associates reported on the use in anesthesia of a unique compound, Sernyl or CI 395, a cyclohexylamine which was found to produce analgesia without loss of consciousness. The intravenous use of 0.2 mg. per kilogram caused 'complete insensibility of pain' often associated with amnesia but without overt stupor. The site of action was considered to be at the thalamic level. With these findings, utilization of this agent in thalamic pain seemed appropriate, and Stevens in fact stated that unpublished observations supported its efficacy in this state. Available for trial were 3 compounds of this series: CI 395, CI 400, and CI 401. . . .

"The effects of [the] 3 cyclohexylamines were studied in a patient with thalamic pain. . . . In this patient, CI 401 caused leukopenia and uremia in only eight days; when CI 400 was given for over a month, borderline azotemia and electroencephalographic changes were found. Both of these agents seemed to lessen the pain. CI 395 given for five months did control effectively the thalamic pain without recurrence after its withdrawal. However, termination of its use was necessitated by an acute delirioid reaction with some residual brain damage. . . .

"It is concluded that these cyclohexylamines may provide an effective but hazardous treatment for thalamic pain and that their use is warranted in this disorder with appropriate safeguards."

Perria, Luigi; Rosandi, Guido and Rossi, G. F.: Determination of side of cerebral dominance with amobarbital. Arch. Neurol. 4: 173-181 (Feb.) 1961.

"Every neurosurgeon is well aware of the great risk of a mistake in the identification of the hemisphere which controls speech, or dominant hemisphere. . . . A study has been made of the possibilities of the method introduced by Wada for determining the side of cerebral dominance by intracarotid injection of sodium amobarbital. The study was performed on 30 adult subjects. . . .

"The following conclusions have been reached: 1. The occurrence of speech disturbances and the development of an emotional reaction of depressive type indicate that the drug

is acting on the dominant cerebral hemisphere. The absence of speech defects and an emotional reaction of euphoric type indicate that the drug is acting on the nondominant hemisphere. 2. The signs relating to hemisphere specialization can be taken into account only when the amobarbital effects on the EEG, motor power, and reflexes are evident and clearly lateralized."

Astrom, A. and Persson, N. H.: Some pharmacological properties of o-methyl-a-propylaminopropionanilide, a new local anaesthetic. Brit. J. Pharmacol. 16: 32-44 (Feb.) 1961.

"In recent years investigations of compounds chemically similar to lignocaine have been initiated because of the favourably clinical results obtained with this local anaesthetic. In collaboration with Lofgren and his associates a large number of lignocaine analogues have been synthesized and tested in our laboratories. One such compound is o-methyl-a-propylaminopropionanilide (L 67, Astra). . . .

"In the study presented here the local anaesthetic properties of L 67 have been investigated in vitro (isolated frog nerve) and in vivo (nerve block, surface and spinal anaesthesia) in rats and rabbits. The action on the circulation and respiration and the toxicity of the drug have also been evaluated. . . .

"With the appropriate caution with which experimental results on animals always should be regarded when used to predict clinical usefulness of a compound, we would like to conclude that due to its favourable local anaesthetic activity and tolerance L 67 may prove to be a useful anaesthetic in certain clinical applications. On the mucous membranes in the respiratory tract and probably elsewhere its effectiveness may be expected to be of the same order of magnitude as that of lignocaine. . . .

"It remains to be determined, however, if the lower relative efficiency of L 67 in comparison with lignocaine, as found on the isolated nerve preparation, will make it inferior to lignocaine in sites where a more extensive and profound action is required. For certain clinical applications it should also be considered that the action of L 67 cannot be prolonged by the addition of adrenaline to the same degree as lignocaine."

Kittle, C. F. and Reed, W. A.: Antibiotics and extracorporeal circulation. J. Thoracic & Cardiovascular Surg. 41: 34-48 (Jan.) 1961.

"We should like to summarize the type and incidence of postoperative infections in all 222 patients who had mitral valvotomy, transection of ductus arteriosus, repair of coarctation of the aorta, and operations with the use of extracorporeal circulation at the University of Kansas Medical Center during the period from Sept. 15, 1957, to March 1, 1960. This is the period during which extracorporeal circulation has been used. The study was terminated on March 1 to include the first postoperative month. . . .

"The patients have been subdivided into those who received prophylactic antibiotics and those who did not. The occurrence of infection was as great in those patients receiving prophylactic antibiotics as in those who did not. Generally, organism sensitivity in the former group was less. Our experiences do not support the policy of routine antibiotic prophylaxis postoperatively for patients having thoracic cardiovascular procedures."

Classified Advertisements

NURSE ANESTHETIST for 3 p.m.-11 p.m. shift. Interesting variety of cases. Assumes 7:30 a.m.-4:00 p.m. shift when vacancy occurs. Salary to $6,084.00. Apply: D. C. Weaver, M.D., Grace-New Haven Community Hospital, P. O. Box 1001, New Haven, Conn.

NURSE ANESTHETISTS—Immediate openings for qualified registered nurses in 450 bed short term general hospital with active surgical program. Opportunity to associate with three board certified anesthesiologists. Salary commensurate with experience and training. Write, furnishing outline of experience, to Director of Anesthesia, Delaware Hospital, 501 W. 14th Street, Wilmington 99, Delaware.

IMMEDIATE OPENING FOR NURSE ANESTHETIST: 60-bed hospital needs two Nurse Anesthetists to complete Surgery Staff, near college town, paid vacation, sick leave, and other liberal fringe benefits. Salary open. Reply to Administrator, Terry County Hospital, P. O. Box 112, Brownfield, Texas.

NURSE ANESTHETIST: Salaries from $5,885 to $7,425, depending upon experience. Positions under Civil Service Merit System. 40 hour basic work week; liberal vacation and sick leave plan; health, life insurance and retirement plans. Excellent opportunities for advanced training and experience in large general hospital with active teaching and research programs. Apply, Personnel Officer, D. C. General Hospital, Washington 3, D. C.

MAINE MEDICAL CENTER. Excellent opportunity for Certified Nurse Anesthetist who enjoys coastal and inland recreation. Two hour drive from Boston. Congenial staff of four physicians, six Surgical Nurse Anesthetists, two night Obstetrical Anesthetists. For details write: John R. Lincoln, M.D., Director of Anesthesia, Maine Medical Center, Portland, Maine.

WANTED — Lady Nurse Anesthetist — Group of 7 Physicians and 7 Nurses — Salary open — Contact Albuquerque Anesthesia Service, Medical Arts Square, N. E., Albuquerque, N. Mex.

NURSE ANESTHETIST: 550 bed hospital. Anesthesia Department consists of one M.D. and twelve Nurses. Positions open for two additional Anesthetists. Write to Director of Anesthesia, Harrisburg Polyclinic Hospital, Harrisburg, Pa.

URGENT — Third Female CRNA needed to free lance in 100 bed accredited hospital. Additional information on request. Contact: Chief Anesthetist, Ephraim McDowell Memorial Hospital, Danville, Ky.

TWO NURSE ANESTHETISTS: Wanted for General Hospital to complete staff of seven. Forty hour week, no OB call except emergencies. On weekend call every six weeks. Three week vacation. Write to: Mr. Robert Sherrod, Nashville General Hospital, Nashville, Tenn., or call AL 5-6311.

REGISTERED NURSE ANESTHETIST to complete staff of four in 125 bed approved hospital. Salary open. Contact John R. Gadd, Administrator, Lee Memorial Hospital, Fort Myers, Fla., the "City of Palms."

NURSE ANESTHETIST — for 100 bed General Hospital, to complete staff of three. New, modern, air conditioned hospital located in Midwest University town. Salary open dependent on qualifications and experience. Write: Jack Edmundson, Administrator—Doctors Hospital—Carbondale, Ill.

WANTED—Trained Nurse Anesthetists to work with a qualified M.D. Anesthesiologist in a New England coastal community hospital. State qualifications and present salary. Apply: Administrator, Portsmouth Hospital, Portsmouth, N. H.

NURSE ANESTHETIST: Immediate opening in 85 bed hospital. Salary open with laundry of uniforms included. Three weeks vacation after first year, 4 weeks each year thereafter. Sick leave, holidays, pension retirement plan, Blue Cross - Blue Shield, Social Security, group insurance available. Contact Hospital Director, Memorial Hospital of Bedford County, Bedford, Pa.

POSITIONS OPEN for A.A.N.A. member to increase to staff of five. Large University Hospital, excellent staff with wide variety of Surgical cases, including Thoracic Surgery. Two weeks paid vacation, cumulative sick leave and six paid holidays. Other fringe benefits if desired. Starting salary with compensation for call duty averages $570.00-$600.00. Five day week. Contact Miss Ramona Kersey, Chief Nurse Anesthetist, Firmin Desloge Hospital, St. Louis 4, Mo.

WANTED: REGISTERED NURSE ANESTHETIST. East Tennessee Area. Starting salary, $600.00 per month for a 40 hour week. Opportunity for additional call-time-income. Well supervised department, 400 bed hospital. Box B-71, Journal American Association of Nurse Anesthetists, Prudential Plaza, Suite 3010, Chicago 1, Illinois.

NURSE ANESTHETISTS — For new 800 bed teaching hospital with modern operating room facilities; liberal personnel policies; group life, hospitalization, retirement benefits. Pleasant working conditions. Salary commensurate with training and experience. Residence accommodations available. Write to Personnel Director, Grady Memorial Hospital, 80 Butler St., S. E., Atlanta 3, Ga.

ANESTHETIST—Nurse to complete staff of three for modern 100 bed hospital; Winter ski and Summer boating area in beautiful Southern Vermont; start $6500 per year; 4 weeks vacation, sick time, Blue Cross, etc. Apply Ronald H. Neal, M.D., Chief, Department of Anesthesiology, SPRINGFIELD HOSPITAL, Springfield, Vt.

SURGERY ANESTHETIST for 870 bed hospital. Salary open. Liberal employee benefits. Write John R. Mote, Assistant Director, Methodist Hospital, Indianapolis, Ind., for further information.

WANTED: Nurse Anesthetist for 156 bed hospital in town of 6,000 in lower South Carolina 50 miles from Charleston. Attractive living conditions, working hours, fringe benefit. Salary open. Please contact by letter or wire, T. B. Stevenson, Superintendent of Colleton County Hospital, Walterboro, S. C.

NURSE ANESTHETIST, Male or Female, for hospital on Staten Island, N. Y., excellent conditions. Write: Box B-44, Journal American Association of Nurse Anesthetists, Prudential Plaza, Suite 3010, Chicago 1, Ill.

WANTED: C.R.N.A. for 160 bed Mid-western hospital. Excellent Personnel Policies and fringe benefits. Starting salary $475, with $25 merit raise in six months; additional pay for call. Reply to Box B-68, Journal American Association of Nurse Anesthetists, Prudential Plaza, Suite 3010, Chicago 1, Illinois.

NURSE ANESTHETIST—C.R.N.A. to work with Anesthesiologist in 100 bed hospital. College town. Liberal employment policies. Salary open. Contact L. E. Wells, M.D., Southside Community Hospital, Farmville, Va.

NURSE ANESTHETIST — $500. New and Modern Surgery: unusually strong and well diversified Surgical Staff. Good opportunity in new 260-bed hospital; college town location; good personnel policies; 40-hour week; 7 holidays, hospitalization. Social Security. Apply: Carl Renz, Personnel Assistant, Chambersburg Hospital, Chambersburg, Pa.

NURSE ANESTHETIST — 500 bed hospital. Anesthesia Department consists of three M.D. and thirteen Nurse Anesthetists. Write to Medical Director, Crawford W. Long Hospital, Atlanta, Georgia.

NURSE ANESTHETIST to complete staff of three serving 130 bed hospital, fully approved by JCAH. Excellent salary; liberal Personnel Policies. Modern furnished apartment. Additional information on request. Pulaski Hospital, Pulaski, Va.

NURSE ANESTHETIST: 364 bed General Hospital being enlarged to 500 beds. Want to enlarge present staff of 2 M.D.'s plus 8 Anesthetists. Salary to $500 per month plus extra bonus payment per case on call duty and retirement and sickness benefits. New air conditioned Operating Rooms. Apply: Chief, Department of Anesthesia, York Hospital, York, Pa.

REGISTERED NURSE ANESTHETISTS: 690 bed hospital, primarily surgical. Integral part of developing 236 acre Detroit Medical Center. Emergency surgery only on Saturdays. Salary commensurate with qualifications. Excellent personnel policies. Write or call Personnel Director, Harper Hospital, Detroit 1, Michigan.

OPENING for two Nurse Anesthetists, who have preferably just completed training, to fill positions created by expansion program including the addition of a new building and enlarged operating suite. Leading community hospital in the leading University City of the Northeast. Forty hour week plus call. Beginning salary minimum $480 plus remuneration for call. Liberal vacation and sick leave. Apply James H. Buskirk, Director, Department of Anesthesiology, Mount Auburn Hospital, Cambridge, Mass.

WANTED: Registered Nurse Anesthetist for completely new 150 bed air conditioned hospital. Vacation, sick leave, Social Security. 1 hour drive from Atlantic Ocean beaches and Norfolk, Va. Pleasant working conditions —write or call Mrs. Mattie A. Foster, CRNA, Albemarle Hospital, Inc., Elizabeth City, N. C.

WANTED: Asheville, North Carolina — Two Nurse Anesthetists — Work with four Nurses and two MD's. City of 60,000 in beautiful Blue Ridge Mountains. Minimum starting salary $550. Contact Drs. Ambler & Hoskins, 203 Doctors Bldg., Asheville, N. C., for further details if interested.

ANESTHETIST — Nurse to work with Anesthesiologist in 116 bed General Hospital near Pittsburgh. Good salary and liberal employment policies. Apply Beaver Valley General Hospital, New Brighton, Pa.

NURSE ANESTHETIST — Registered, well experienced in all types of Anesthesia for fully accredited 154 bed General Hospital. Combined duties with Surgery and Obstetrics. 40 hour week; salary based on experience and qualifications; paid on call time; liberal Personnel Policies. Applicant send resume including experience, date available and salary desired to Personnel Manager, Beyer Memorial Hospital, 28 S. Prospect, Ypsilanti, Mich.

NURSE ANESTHETIST—To complete staff of four for 211 bed General Hospital. No OB call. Starting salary $6,300. Excellent working conditions. Contact: Administrator, Bluefield Sanitarium, Bluefield, W. Va.

ANESTHETIST for 209 bed General Hospital in Resort Area Northwestern Pennsylvania Town of 18,000. T. McFarland, Chief Anesthetist, Bradford Hospital, Bradford, Pa.

NURSE ANESTHETIST — 154 bed General Hospital in rural community, 125 miles North of New York City on Hudson River and NYCRR. MD Anesthesiologist plus three Nurse Anesthetists in department. Full maintenance available to Female applicants. Salary open. Contact Administrator, Columbia Memorial Hospital, Hudson, New York.

IMMEDIATE OPENING for Nurse Anesthetist, 230 bed hospital, liberal Personnel Policies, paid vacation and sick leave, starting salary $550 mo. Reply Box M-77, JAANA, 3010 Prudential Plaza, Chicago 1, Ill.

WANTED: Additional Nurse Anesthetist for 60 bed hospital. Surgical Anesthesia and share Obstetrical Anesthesia call. For further information write to Mrs. Dorcas V. Martin, Administrator, Brown Memorial Hospital, Conneaut, Ohio.

WANTED — Nurse Anesthetist, CRNA, for third member of a 3 man team; 90 bed hospital in Doylestown, Bucks County, Pennsylvania; Surgical and Obstetrics. Salary open. Write or call the Administrator, Doylestown Hospital, Doylestown, Pa. Fillmore 8-2901.

NURSE ANESTHETIST—for Anesthesia Department comprised of 4 MD's and 5 RNA's. Attractive and inexpensive living accommodations available. Salary $436 per month for 40 hour week, plus overtime while on call. Apply Mr. L. R. Currier, Assistant Director, Elizabeth General Hospital & Dispensary, 925 E. Jersey St., Elizabeth, N. J.

WANTED — Young Female Nurse Anesthetist for newly expanded and renovated 222 bed hospital 30 miles North of Boston. We presently employ 3 full time Nurse Anesthetists and 2 full time Physician Anesthesiologists. Salary according to training and experience. Mountain, beach and resort areas nearby. Contact Harold S. Wright, Jr., M.D., Chief of Anesthesia, Hale Hospital, Haverhill, Mass.

NURSE-ANESTHETIST

Exp'd. Air-cond. O.R. suite in large general teaching hospital—$109 up per week start+overtime. Write Dr. Owre

L. I. COLLEGE HOSPITAL

c/o Anesthetist Dept., 340 Henry St., Brooklyn, N. Y.

NURSE ANESTHETISTS — 2 VACANCIES. Well trained girls desired; new, modern 400 bed General Hospital. Suburban Phila.; 8,000 Anesthetics per year of every type; one month vacation; $435 per month to start, more if experienced; department consists of 4 Doctors and 7 Nurses. Write or contact Thales Bowen, Jr., M.D., Dept. of Anesthesiology, Lankenau Hospital, Philadelphia 51, Pa.

NURSE ANESTHETIST—For modern, recently expanded 250 bed General Hospital. Excellent benefit program including free Blue Cross, free life insurance, meals below cost and a retirement program. Salary — $465 per month. Call pay averages $100 additional per month. For more information contact Personnel Director, Louis A. Weiss Memorial Hospital, 4646 Marine Drive, Chicago 40, Ill.

WANTED: NURSE ANESTHETISTS—to increase present staff under direction of Anesthesiologist in Medical Center located in State Capitol. 1,300 bed hospital and graduate schools. Salary range $5,880 - $7,344. Eleven holidays; twelve paid vacation days; fifteen day sick leave. Regular merit increases provided. No Obstetrical Call. Write Chief Anesthetist, Medical College of Virginia Hospital, Richmond, Va.

NURSE ANESTHETIST — Operating Room and some Obstetrical Anesthesia. Modern air conditioned facilities. Accredited 380 bed General Hospital. Salary open; liberal employee benefits. Apply: Miss Lucy Richards, Head Nurse Anesthetist, Lutheran Hospital, 2609 Franklin Blvd., Cleveland 13, Ohio.

NURSE ANESTHETISTS—300 bed modern progressive hospital. Excellent working conditions and benefits including shift differential bonus, 3 weeks vacation, liberal sick leave, retirement. 40 hour week including call hours. Supervised by 3 M.D. Anesthesiologists. Apply Personnel, New Britain General Hospital, New Britain, Connecticut.

NURSE ANESTHETIST: 211 bed hospital. Completely modern Operating Suite being completed as part of a new building program. Three weeks vacation after the first year and four weeks each year thereafter; sick leave, holidays, and retirement plan. Salary commensurate with experience. Contact: Personnel Director, St. Alexius Hospital, Bismarck, N. Dak.

NURSE ANESTHETISTS: Openings at two General Hospitals, Homer Phillips Hospital and City Hospital. Salary range is $511 to $621 per month. Forty hour week, sick leave, three weeks vacation, eleven paid holidays, and pension plan. Department of Personnel, City of St. Louis, 235 Municipal Courts Bldg., St. Louis 3, Mo.

NURSE ANESTHETIST: Male or Female for new 340 bed General Hospital. Opportunity to work with two Anesthesiologists. Most modern facilities and equipment. 40 hour week with limited call. Salary commensurate with experience and ability. Liberal fringe benefits. Hospital completely air conditioned overlooking beautiful Lake Decatur. Apply Personnel Director, St. Mary's Hospital, Decatur, Ill.

NURSE ANESTHETIST WANTED for large Obstetrical Department. 40 hour week. Minimum starting salary $500 per month. Periodic pay increases. Two week vacation (3 weeks after 5 years), Social Security and sick benefits. Additional income available if overtime desired to augment income. Interested parties inquire: Administrator, St. Mary's Hospital, 6420 Clayton Road, St. Louis, Mo.

ONE NURSE ANESTHETIST for 220 bed General Hospital. City located 60 miles North of Milwaukee on Lake Michigan. Much and diversified experience. Salary dependent upon experience. Four weeks vacation after one year of service, twelve paid sick days and six paid holidays per year. Insurance benefits if desired. Apply: Administrator, St. Nicholas Hospital, Sheboygan, Wis.

WANTED: Two Registered Nurse Anesthetists for 500 bed, fully accredited hospital with School of Nursing. Salary open, liberal benefits. Write Personnel Office, St. Joseph Mercy Hospital, Ann Arbor, Mich.

NURSE ANESTHETIST — Modern, accredited, 55 bed hospital, Manistique, in the beautiful Upper Peninsula of Michigan. Starting salary $6,600, advances based on merit. Liberal Personnel Policies. Apply to H. B. Purdy, Administrator, Schoolcraft Memorial Hospital, Manistique, Mich.

WANTED: Nurse Anesthetist on or before January 1st, 1962 for 120 bed General Hospital in desirable Long Island resort community. Building program will provide entirely new Operating Room and Recovery Room areas. Contact James E. Jenkins, Administrator, Southampton Hospital, Southampton, N. Y.

WANTED—Nurse Anesthetist for the Southeastern Kentucky Baptist Hospital, 75 beds, general, fully accredited hospital. This is a wonderful town in which to live, located between two state parks, one being Cumberland Falls State Park, the other Levi Jackson State Park. Salary open, the usual fringe benefits. If interested contact W. J. Bishop, Administrator, Southeastern Kentucky Baptist Hospital, Corbin, Ky.

WANTED — Registered Nurse Anesthetist for Oral Surgeon. 9-3, 4½ days, 23 hours. $650 per mo. pd. vac. Write Box B-73, JAANA, 3010 Prudential Plaza, Chicago 1, Ill.

NURSE ANESTHETIST—To work in 500 bed Veterans Administration teaching hospital. Qualifications: Graduation from a recognized School of Nursing, supplemented by completion of an accredited course in Anesthesia. Possession of a license or eligibility in any state required. Salary range $4,760 to $7,560, depending upon qualifications and experience. For full particulars write to Manager, VA Hospital, 915 N. Grand Blvd., St. Louis 6, Mo.

NURSE ANESTHETIST: Immediate opening in active 200 bed VA Hospital. Salary $4,760 to $10,255 yearly dependent on qualifications. Fringe benefits: Retirement, paid vacation and sick leave, group life and hospitalization insurance. Requirements: Citizenship, current registration as Graduate Nurse and graduation from approved School of Anesthesia. Write or call Manager, VA Hospital, Beckley, W. Virginia.

REGISTERED NURSE ANESTHETIST, starting salary $600 per month. Advances based on merit and tenure. Liberal Personnel Policies, including one of the better retirement plans. Hospital 268 beds and expanding, fully accredited, located in a good North Shore Community. Please contact Personnel Director, Victory Memorial Hospital, Waukegan, Ill.

ANESTHETIST — Immediate need for Male or Female Registered Nurse Anesthetist to work in Anesthesia Department presently composed of three Anesthesiologists and seven Nurse Anesthetists. Excellent pay, one month vacation, eight paid holidays, pension plan, good working conditions, additional pay for call time. Latest equipment, techniques, and agents used in progressive 435 bed hospital. Apply: Director of Anesthesia, Waterbury Hospital, Waterbury, Conn.

ANESTHETIST — Nurse; 54 bed General Hospital in SW Ohio; expansion planned; salary range: $7,200-$8,500, usual benefits, 40 hour week. Apply: Administrator, Adams County Hospital, West Union, Ohio.

NURSE ANESTHETIST for accredited 191 bed hospital expanding to 250 beds, with new Surgical and Anesthesia facilities. Located 40 miles East of Pittsburgh, good Personnel Policies, paid vacation and sick leave, salary open depending on experience. Reply to: Administrator, Latrobe Hospital, Latrobe, Pa.

NURSE ANESTHETIST for hospital in Boston. Salary $6,000-$6,800 annually. Eligible or member AANA. Four weeks vacation and 10 paid holidays per year. Forty hours weekly. Free hospitalization. Easy call duty: one night every two weeks, one weekend every two months. Write giving training and experience to Box B-78, JAANA, 3010 Prudential Plaza, Chicago 1, Illinois.

TEMPORARY JOB, 2 months, start end of October, $900 a month, plus living quarters, modern County Hospital, Maquoketa, Iowa. Write Dr. Silveira, Jackson County Public Hospital.

EXPERIENCED NURSE ANESTHETIST, Male preferred, needed at once in a new, modern New England Hospital, under pleasant working conditions. Box B-77, JAANA, 3010 Prudential Plaza, Chicago 1, Ill.

WANTED: Nurse Anesthetist (Female) to join staff of four Physicians and three Nurse Anesthetists in lower Connecticut. Prevailing Connecticut salary—liberal vacation and sick leave. Reply: Box B-50, JAANA, 3010 Prudential Plaza, Chicago 1, Ill.

IMMEDIATE OPPORTUNITY available for Registered Nurse Anesthetist at hospital located in the heart of the fastest growing city in the intermountain west—Ogden, Utah. 240 bed hospital, liberal policies and open salary. Please write, wire, or make application to Director of Personnel, Thomas D. Dee Memorial Hospital.

NURSE ANESTHETIST: Female, to complete staff of 8 Nurse Anesthetists in fully accredited 250 bed general, community hospital. Forty hour week, prevailing salary, vacation, sick leave, Social Security. Pleasant working conditions. Nearby beaches. Apply to Director, James Walker Memorial Hospital, Wilmington, North Carolina.

NURSE ANESTHETIST to complete staff of one anesthesiologist and three anesthetists in 197 bed accredited hospital. $575 starting salary, $600 after first six months. Hospital shares Blue Cross premium, gives discount on outpatient drugs besides other liberal benefits. Hospital centrally located in the clean, beautiful capital city of North Dakota. Population 28,000. Contact Donald E. Hansen, Administrator, Bismarck Hospital, Bismarck, North Dakota.

NURSE ANESTHETISTS to "Meet Me in St. Louis." Male or female to work in 350 bed hospital. Liberal vacation, hospitalization, sick leave, good transportation, congenial staff. Salary open. Other advantages include two well-known Universities, outdoor and indoor theater, symphony and professional sports. Apply: George Benjamin, Personnel Director, DE PAUL HOSPITAL, 2415 N. Kingshighway, St. Louis 13, Missouri.

WANTED: NURSE ANESTHETIST by October 15. 60 bed General Hospital. Liberal policies, good salary and working conditions. Contact: Sister M. Sabina, Administrator, St. Anthony Hospital, Morrilton, Ark.

OPENING for a Nurse Anesthetist. Contact Bert H. Ellis, M.D., Glynn-Brunswick Memorial Hospital, Brunswick, Georgia.

NURSE ANESTHETIST — Female. 350 bed accredited new modernistic hospital. One month vacation. Sick leave. Insurance benefits. Eight holidays. $500 per month. Located in beautiful Central Florida. Contact Personnel Director, Lakeland General Hospital, Lakeland, Fla.

NURSE ANESTHETISTS: Night position; $500.00 for 44 hour week, no call; Sunday off. Day position; 40 hour base; salary and call pay $500.00 per month plus, depending on experience. Excellent working conditions and fringe benefits. Anesthesiologist Director. Apply to Personnel Director, St. Joseph Hospital, 1401 S. Main, Fort Worth, Texas.

NURSE ANESTHETIST: For immediate opening in 320 bed, fully accredited hospital, currently undergoing a major remodeling and expansion program. Excellent location. Liberal benefits. Apply to: Personnel Director, St. Anne's Hospital, 4950 West Thomas Street, Chicago 51, Illinois.

Legislation

(Continued from page 292)

have been the cord which caused her to fall as there was nothing else. When plaintiff was found, the cord was around her foot completely and the cord was pulled from the plug. The defendant was aware that the plaintiff frequently used the area where the cord was located. In her testimony the plaintiff stated, "That is what I reckon made me fall. I can't imagine why I fell, because I was perfectly well and I was able to go about and do what I wanted to do."

The plaintiff suffered a fracture of the left hip at the neck of the femur, which required a total hip prosthesis or hip replacement and she will be disabled from walking for the rest of her life without the use of a walker. She also suffered various hospital and medical expenses, which we shall not enumerate since there seems to be no question as to their reasonableness.

The defendant herself testified that when she found the plaintiff, the cord was wrapped completely around her leg and pulled from out of the plug. We consider that this and the other evidence is sufficient to point to the cause of the plaintiff's fall.

The case was tried before the court without a jury and judgment was rendered in the amount of $7,500.

(Dunahoo v. Brooks, 12 CCH Neg. Cases 2d 717 - Ala.)

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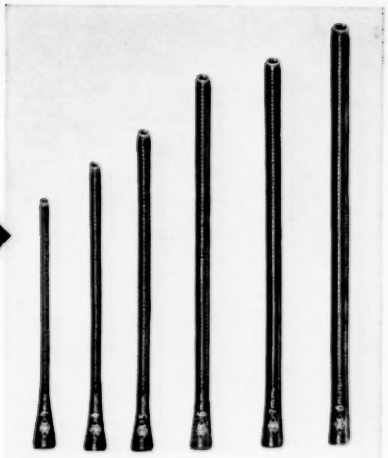

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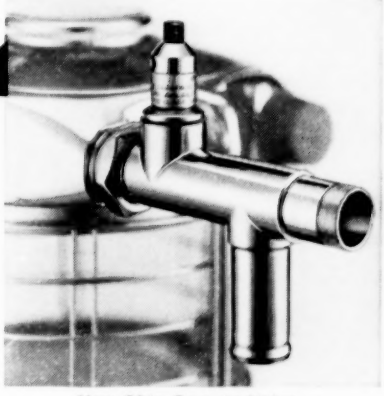

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